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When academics integrate research skill development in the curriculum

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This study considered outcomes when 27 academics explicitly developed and assessed student research skills in 28 regular (non-research methods) semester-length courses. These courses ranged from small ($n = 17$) to medium-large ($n = 222$) and included those from first year to masters in business, engineering, health science, humanities and science, across five universities in three Australian cities. The two-year study used three data sets to determine the outcomes of development and assessment initiatives: student pre- ($n = 779$) and post-questionnaires ($n = 601$), interviews with students ($n = 46$) one year after completing a course that developed research skills and interviews with academics ($n = 17$) involved in developing and assessing student research skills. These multiple sources provided evidence that students developed a variety of discipline-specific research skills and that these skills were useful for subsequent studies and especially for employment. Academics indicated that the process of making explicit the development of student research skills led to enhancement of their teaching, helping the academics to clarify major course purposes as well as enabling them to provide more substantial feedback to students than in the past. Academics also indicated that this teaching process changed their understanding of disciplinary research and, for some, even suggested new directions in their research.

Keywords: curriculum renewal; research skill assessment; research skill development; teaching research linkages; undergraduate research

Introduction

> She suddenly realised that students did not know where the material in her lectures came from, that they seemed to think it was just there for her to tell them about; they did not recognise the years of research in the field, the teacher's own research to enable her to present that knowledge, or that they themselves are engaged in a research process when they attempt to learn. (Nightingale, 2009, p. 7)

What often unites teaching and research is a common sentiment among academics: passion for the discipline. This union has been formalized in universities internationally, with teaching and research required in most academics' job descriptions. However, in many cases, teaching and research practice, rather than being united, may merely coexist on parallel trajectories in the activities of individual academics, in programmes of study and in whole institutions. Calls for a convergence of these trajectories have been made for two decades and continue unabated (Boyer, 1990;

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Boyer Commission, 1998; Brew, 2006, 2010; Griffiths, 2004; Hathaway, Nagda, & Gregerman, 2002; Ishiyama, 2002; Jenkins, Breen, & Lindsay, 2003; Visser-Wijnveen, Van Driel, Van der Rijst, Verloop, & Visser, 2010).

One realistic way of bringing teaching and research together in learning environments is for academics to explicitly develop student research skills in regular semester-length courses (Chaplin, 2003; Hoskins, Stevens, & Nehm, 2007; Luckie, Maleszewski, Loznak, & Krha, 2004), immersing students in the discipline, not only for its content, but also for its knowledge-making practices (Chanock, 2004). Determining the methods and outcomes of explicitly developing student research skills is a contemporary international agenda, with the goal 'to move more *curricula* in the direction of *developing* students as participants in research and inquiry' (Jenkins & Healy, 2009, p. 6, emphasis added). However, there are few studies of the methods and outcomes of developing students as research participants in regular course curricula (Willison & O'Regan, 2007). What is needed, therefore, is evidence from diverse contexts that developing students as participants in research is doable and produces desirable outcomes, also necessary is the documentation of how outcomes were attained. These gaps are addressed here in a study of the outcomes of a strategy for making explicit student research skill development and assessment in numerous contexts.

Conceptual framework

Academics involved in the study[1] used the Research Skill Development (RSD) framework (Willison & O'Regan, 2006) as the conceptual model for the strategy. The RSD brings together multiple educational understandings in a concise framework incorporating: student autonomy (Boud, 1988; Butler, 1999), Information Literacy standards (Australian & New Zealand Institute of Information Literacy, 2004), Bloom's cognitive realm taxonomy (Bloom, Engelhardt, Furst, Hill, & Krathwohl, 1956) and personal constructivist (Kelly, 1955), social constructivist (Vygotsky, 1978) and objectivist/instructivist perspectives.

The RSD explicates six facets of research, whereby students embark on inquiry, find information/generate data, evaluate information/data and the research process, organize information/data and manage the research process, analyse, synthesise and apply new understandings, and communicate knowledge with an awareness of ethical, social and cultural issues. Each of these six facets are elaborated into a five-level continuum of student autonomy, where 'Level 1' indicates a low degree of student autonomy, with highly prescribed and guided tasks, and 'Level 5' indicates a high degree of student autonomy, where they initiate research tasks (for details, see Willison & O'Regan, 2007).

Empirical research utilizing the RSD in the context of first-year Human Biology (Peirce, Ricci, Lee, & Willison, 2009; Willison, Peirce, & Ricci, 2009) and Business at undergraduate and masters levels (Willison, Schapper, & Teo, 2009) showed positive student outcomes when their research skills were explicitly addressed. Based on its conceptual guidance and on potential shown in these studies, the RSD framework was selected for use by academics involved in the current study.

Research context

Of the five universities in the study, three were Research Intensive, one was a Technology Network university and the other did not have a specific classification.

The 27 academics in the study coordinated courses ranging from first-year to masters level, in Animal Science, Business Ethics, Business Law, Electronic Engineering, English, Human Biology, Human Resources Management, Integrated Academic Programme, Introduction to Tertiary Learning, Media Studies, Nursing, Oral Health, Psychology, Software Engineering and Tourism.

As a minimum requirement of the study, academics reframed one or more assessment tasks in one course by structuring marking matrices (rubrics) according to the RSD, but adapting these to the context. A total of 28 courses were modified in such a way. In each case, clarity of assessment purpose and coherence of learning objectives and assessment were enhanced by the provision to students in advance of the assessment criteria. Beyond the marking matrices, how academics made research skill development explicit varied from discipline to discipline, course to course. Strategies included modelling research skills, such as question posing or evaluating sources in lectures, clarifying that skills required for specific tasks were those associated with research in a discipline and specifying that reading articles was a way of engaging with a research community. In general, academics found that because they were clearly assessing research skills, they were more explicit in the teaching of those skills than they had been previously (Nightingale, 2009).

Research questions

This study was guided by three pertinent questions, which emerge from Jenkins and Healey's (2009) push for curricula designed to develop students as participants in research:

(1) Is it practical, across multiple contexts, to implement curricula that explicitly develop student research skills?
(2) What are the advantages and disadvantages, for students and academics, of explicitly developing and assessing students' research skills in the curriculum of regular courses?
(3) What factors support student research skill development, and what factors hinder its development in regular courses?

Research methods

To address the research questions, different methods and stakeholders were utilised. These multiple perspectives provided triangulated data, which enhanced the credibility of emerging assertions (Guba & Lincoln, 1989) and included student self-assessment of research skill, interviews with students and interviews with academics, as described below.

Student self-assessment of research skills

Student self-assessment was effected with pre- and post-questionnaires comprised of 15 Likert-scale items, administered in paper form during teaching sessions and reported in Table 1. The first nine Likert-scale items made statements about the students' research skills, while the remaining six made statements about the nature

of research in the discipline and elicited student attitudes to research (listed in the results section). All items required a response, ranging from strongly disagree (1) to strongly agree (7). Pre- and post-course questionnaires were successfully piloted in 2008 in both a masters course and an undergraduate course (Willison, Schapper, & Teo, 2009).

Interviews with students

Students were interviewed one year after their completion of a course that explicitly developed their research skills. In total, 46 students, out of 58 invitees, were interviewed in 2008 or in 2009 from six disciplines selected to represent major faculty groupings: Human Biology (13 students out of 18 invited), Nursing (9 out of 9), Business Ethics (8 out of 9), Software Engineering (7 out of 9), Oral Health (5 out of 9) and English (4 out of 4). The hour-long interviews were recorded and participants were given compensation as per the ethics-committee approved protocol.

The research questions required elements in common to be addressed in all interviews, yet for there to be sufficient openness for different experiences and understandings to emerge, so a semi-structured interview protocol was utilized (Wengraf, 2001). Questions focused on: determining advantages and disadvantages of the process each student experienced when research skills were explicitly taught, factors that helped their skill development and factors that hindered it, and how any skills developed may have proved to be of use. To optimize spontaneous responses, no pre-planned questions were framed around specific research skills.

For four courses, student interviewees represented the range of abilities in their cohort, as determined by their course grades. Only stronger students were sought for interview from the English course, due to the complexities of the first implementation of RSD in the Humanities. Moreover, underperforming students were targeted from Human Biology because the pilot interviews for the study, all conducted with Human Biology students in 2006 and 2007, were attended in the main by students who made substantial improvements in skills, possibly biasing pilot data (Peirce et al., 2009).

Student interview transcripts were analysed independently by the project leader, project research officer and project manager. The analysis involved determining themes that addressed research questions two and three. Cross-checks of themes were conducted until consensus was reached (Willison, Le Lievre, & Lee, 2010). Subsequently, analysis was continued by the project research officer, with ongoing cross-checks by the other two involved in the analysis.

Interviews with academics

The academic interviewees had developed and assessed their students' research skills and so formulated their professional judgment of outcomes. Of the 27 academics, 17 were available to be interviewed at the time that the external reviewer visited each university and these represented all-but-one discipline, all year levels and four universities in the study. The interview process took the format of hour-long, semi-structured interviews around academics' use of the RSD and their perceived benefits and detriments for students and for themselves. Emergent themes from interviews were identified, as well as salient atypical comments, which together provided insight into aspects of the research questions.

Table 1. Statistical significance value for the difference between pre- and post-questionnaires, item-by-item, in 10 courses with RSD intervention.

Item	1st-year Animal and Vet Science $n^1 = 83$ $a^1 = 0.84$ $n^2 = 67$ $a^2 = 0.81$	1st-year Dentistry $n^1 = 72$ $a^1 = 0.8$ $n^2 = 66$ $a^2 = 0.89$	1st-year Human Biology Sem. 1 $n^1 = 222$ $a^1 = 0.88$ $n^2 = 144$ $a^2 = 0.89$	1st-year Human. Biology Sem. 2 $n^1 = 157$ $a^1 = 0.85$ $n^2 = 78$ $a^2 = 0.86$	1st-year Hum. Res. Management $n^1 = 118$ $a^1 = 0.85$ $n^2 = 115$ $a^2 = 0.89$	1st-year Oral Health $n^1 = 29$ $a^1 = 0.82$ $n^2 = 24$ $a^2 = 0.82$	2nd/3rd-year Business Law $n^1 = 38$ $a^1 = 0.85$ $n^2 = 22$ $a^2 = 0.93$	2nd-year Tourism $n^1 = 22$ $a^1 = 0.94$ $n^2 = 34$ $a^2 = 0.82$	Masters in Business (ethics) $n^1 = 23$ $a^1 = 0.90$ $n^2 = 34$ $a^2 = 0.88$	Masters Software Engineering $n^1 = 15$ $a^1 = 0.84$ $n^2 = 17$ $a^2 = 0.95$	Number of courses with stat. sig score change. (-1) = negative change
1	**0.016**	0.527	0.266	**0.000**	**0.000**	**0.010**	0.126	**0.011**	**0.001**	0.089	6
2	**0.000**	**0.007**	**0.000**	**0.000**	**0.000**	**0.000**	**0.008**	**0.000**	**0.002**	**0.024**	10
3	**0.047**	**0.020**	**0.023**	**0.006**	**0.000**	**0.000**	**0.008**	**0.000**	**0.000**	0.455	9
4	**0.004**	0.411	**0.010**	**0.002**	**0.000**	0.461	**0.004**	**0.000**	**0.001**	**0.008**	8
5	0.211	0.206	**0.047**	**0.004**	**0.000**	**0.001**	0.055	**0.001**	**0.008**	**0.022**	7
6	0.095	0.343	0.852	**0.002**	**0.000**	0.271	0.358	**0.000**	**0.006**	0.202	4
7	0.075	0.069	0.451	**0.006**	**0.000**	0.300	0.416	**0.002**	**0.037**	0.278	4
8	**0.009**	0.132	0.641	**0.025**	**0.000**	**0.030**	**0.001**	**0.001**	0.107	0.261	6
9	**0.022**	0.094	0.729	**0.026**	**0.000**	0.052	**0.003**	**0.007**	**0.003**	0.123	6
10	0.952	0.240	**0.028**	0.971	0.083	0.803	0.078	0.979	0.166	0.176	1
11	0.303	0.819	0.750	0.754	0.441	0.356	0.716	0.056	0.107	0.766	0
12	0.192	0.754	0.260	0.271	0.426	0.316	**0.039** (-)	0.851	0.741	0.682	(-1)
13	**0.007**	0.268	0.942	0.123	**0.023**	0.999	0.186	0.140	0.134	0.433	2
14	0.086	0.458	0.295	0.574	**0.027**	0.287	**0.025** (-)	0.806	0.133	0.350	1 (-1)
15	0.871	0.755	**0.003**	0.361	0.453	0.999	0.229	0.266	0.384	0.682	1

Notes: n^1 = number of students completing pre-, n^2 = post- questionnaire, a^1 = Cronbach's alpha for pre-, a^2 for post-questionnaire; $p < 0.05$, the p-value is in bold.

Results

Pre- and post-questionnaire scores

Table 1 presents the statistical significance value for the difference between the pre- and post-questionnaire sets analysed for the 10 courses from which pre- and post-questionnaires were both provided. For all of the questionnaires, the internal reliability of scores was high, with a Cronbach's Alpha of 0.82–0.93. The Mann-Whitney *U* test was used to determine the probability of changes in Likert-scale scores. The significance level was set at $p = 0.05$. The Likert-scale items with the number of courses with *statistically significant* changes in brackets are:

(1) My general research skills are good (6 courses),
(2) My research skills in [discipline name] are good (10 courses),
(3) I am able to frame research questions in [discipline name] (9 courses),
(4) I can devise procedures in [discipline name] to find information relevant to my inquiry (8 courses),
(5) I can effectively evaluate the credibility of sources of information in [discipline name] (7 courses),
(6) I organise information from multiple sources effectively in [discipline name] (4 courses),
(7) I am able to analyse information effectively in [discipline name] (4 courses),
(8) I can clearly communicate in writing what I understand from my research in [discipline name] (6 courses),
(9) I can clearly communicate in oral presentations what I understand from my research in [discipline name] (6 courses),
(10) By researching [discipline name] I am more able to understand it (1 course),
(11) I would like to be more involved in research (0 courses),
(12) My studies at university require me to do research (1 course negative change),
(13) [Discipline name] research is an activity that has trustworthy outcomes (2 courses),
(14) Research is an activity that influences practices in my discipline (1 course positive change, one course negative change) and
(15) The ability to research will be important in my career (1 course).

Student interviews one year after completing a course that developed research skills

Table 2 presents interview data for the number and percentage of students who commented on the benefits of explicit research skill development. Overall, the 46 students made 292 comments (an average of six different comments per student) about the benefits of having their research skills explicitly developed and 21 comments (average of a half) about the disadvantages of explicit development. Of the 292 comments about benefits, 107 (37%) concerned the development of a specific research skill as framed by the RSD, demonstrating that even one year later many students interviewed were able to articulate skills that they had developed.

While students seemed to value the explicit development of their research skills, they were still often critical of the processes used to achieve this end. Of 550 comments about factors that affected the development of their research skills, 219 (40%)

Table 2. Number and percentage of students across six disciplines who commented in interview about specific *benefits* of explicit research skill development.

Theme about benefit of explicit research skill development	Number of students ($n = 46$) who commented on this	Percent of students who commented on this
Transferable to employment	41	89
Transferable to other courses	35	76
Development of Facet B: find/generate info	33	72
Development of Facet C: critically evaluate	24	52
Development of critical thinking	19	41
Transferable to society	18	39
Development of Facet E: synthesise/analyse/apply	18	39
Sparked further research interest	17	37
Fulfil higher tertiary education (e.g. Honours)	17	37
Development of Facet F: communicate	14	30
Development Facet A: frame research questions	14	30
Motivation	13	28
Awareness of RSD framework in early stage led to incremental autonomy	13	28
Employability	11	24
Development of Facet D: organise information	4	9
Improvement of marks	1	2
Total comments on advantages of explicit research skill development	292	100

concerned factors that negatively affected their development. Of 331 comments regarding factors supporting student research skill development, 223 (67%) were within the control of teaching academics and 145 (65%) of the hindering factors (e.g., lack of clarity) could also be controlled by them.

Table 3 represents the number and percentage of students who commented directly on the role of the RSD to support or hinder their research skill development. The 144 positive comments specifically about the RSD represent 43% of the comments about helpful factors for the development of research skills. The 89 negative comments about the RSD represent 41% of the comments on hindrances of development.

Interviews with academics in the project

The external reviewer found that the use of the RSD as a conceptual framework helped academics, in courses ranging in size from 17 to 222 students, to clarify their own tacit understandings about teaching the discipline:

Table 3. Number and percentage of students who commented about the use of the RSD in ways that supported or hindered research skill development.

Factors that supported the development of research skills ($n = 46$ students) n(%)	Factors that hindered the development of research skills ($n = 46$ students) n(%)
Useful feedback provided by the RSD-informed marking process: 40(87)	Lack of clarity of feedback provided: 17(37) I did not use the feedback provided: 15(33) Eight said both lack of clarity and lack of use
Lecturer use of the RSD Framework helped make clear and explicit the purpose of assessment: 36(78)	Lecturer use of the RSD Framework made assessments complex: 13(28) Lecturer use of the RSD Framework in assessment matrices did not provide enough detail: 3(7)
Forward planning was enabled with clear assessment criteria: 30(65)	Assessment criteria did not enable me to forward plan: 7(15) There was insufficient guidance to move between levels: 9(20)
Lecturer use of the RSD Framework helped develop my autonomy incrementally: 21(46)	Autonomy was not what was expected from course: 9(20)
The use of RSD framework was helpful in generating useful marking criteria: 17(37)	Lack of awareness of relationship between RSD and assessment criteria: 16(35)

> . . . a number of teachers talked about how the RSD added clarity and structure to their goals as teachers and made it possible to articulate aspirations which they already held but rarely expressed explicitly. (Nightingale, 2009, p. 11)

Use of the RSD to structure assessment matrices ultimately had a profound influence on curriculum design where, for example:

> [o]ne academic talked about his realisation that design of one's whole curriculum can be deeply affected by focusing on assessment strategies and clearly defining criteria. (Nightingale, 2009, p. 7)

Changes in curriculum had a consequence for student learning:

> There certainly seems to be development of research skills and the most likely explanation is that the teachers' interventions based on the RSD Framework are, indeed, helping students acquire skills which can be applied in subsequent tasks (Nightingale, 2009, p. 9)

Not only did the use of the RSD affect curriculum design and implementation, but it also had an impact on the academics themselves, their own discipline research and, ultimately, about what is taught and how:

> What was impressive in some interviews in the second year [2009] was the testimony of teachers who said that, almost inadvertently, they found themselves thinking differently about the nature of research within their disciplines, the necessity for students at all levels to appreciate how research is conducted and to be initiated into the process themselves, and about how to inject these new perspectives into their teaching strategies. (Nightingale, 2009, p. 7)

This brings us full circle, with academics' teaching affecting their own discipline research and then their new understanding of research being freshly injected back into their teaching and into their curriculum design, thus allowing them to '... break out of the tired old teaching versus research debate' (Boyer, 1990, p. xii)! Academics evidenced:

> ... enthusiasm about the way the RSD Framework helped them to explain research within the context of their own discipline and to guide students' learning in a logical sequence within a particular subject. In effect, it helps to show that research is part of everyday living and that the skills are constantly valuable. (Nightingale, 2009, p. 10)

The external reviewer found evidence of sustainability of curricula modified in these ways in a case where a key academic discontinued coordinating a course, and another academic:

> ... 'inherited' assessment rubrics based on the RSD Framework. It is unusual for one academic to find the teaching materials of another congenial, and very rare for those materials to be helpful. These assessment rubrics 'worked' even though the new person knew nothing about the RSD Framework until roughly halfway through term. (Nightingale, 2009, p. 6)

Of the 27 academics in the project, 25 continued to embed the RSD in the curriculum in the year following the project and in many cases have expanded their use of RSD. In addition, academics in five degree programmes trialed research skill development embedded in appropriate courses across the entire programme and all have continued to do so. Numerous additional academics in project and non-project universities, including in Canada and USA, have subsequently embedding RSD at the course level.

Discussion

The research data presented above address the three research questions of the study. The data that relates directly to each question is discussed below.

Research question 1. Is it practical, across multiple contexts, to implement curricula that explicitly develop student research skills?

The evidenced uptake of the RSD suggests, that for the involved academics at least, the framework had an intuitive logic that was user friendly, enabling them to implement curricula designed to develop research skills. The RSD is sufficiently flexible to be applied in small-scale modifications, such as in reframing the marking of one assessment, or in an overhaul of the whole curriculum. Use of the RSD in various disciplines, cohort sizes and year levels suggests that as a conceptual framework it may inform interdisciplinary studies, schools, faculties and universities more broadly. However, it is one thing for academics to adopt a framework and implement changes to the curriculum, but a different matter to determine the efficacy of doing this.

Research question 2. What are the advantages and disadvantages, for students and academics, of explicitly developing and assessing students' research skills in the curriculum of regular courses?

Research question 2 was addressed by data in Tables 1 and 2 and the interviews with academics. Almost all positive student interview comments recorded in Table 2 focused

on substantial educational benefits gained from explicit research skill development, with only one comment out of 292 considering 'grading' issues. With a total of 21 student comments made about the disadvantages of the development of research skill, the positive-to-negative comment ratio was 14:1, strongly suggesting that students saw substantial benefits and very few downsides. The five advantages identified below are those indicated in the interview data or questionnaire data, or both, as commonly developed across contexts.

Advantage 1: developing finding and evaluating skills

Table 2 shows that 72% of students reported in interview that a research skill they developed was the ability to devise procedures to find information relevant to the inquiry, with 52% also stating that they developed skills in the evaluation of data and sources. These two results concur with the findings from the questionnaires represented in Table 1, where 8 and 7 out of 10 courses, respectively, showed statistically significant positive changes in students' perceptions about these skills. As teaching academics are often concerned about students' ability to identify and evaluate credible sources, substantial changes in these skills are noteworthy in our era of ready access to information.

Advantage 2: developing the skill of research question framing

Table 2 indicates that 30% of students stated in interviews that their ability to frame research questions improved. This is three times higher than a study based on interviews with undergraduate research students in mentored summer scholarships in the USA (Hunter, Laursen, & Seymour, 2007). While students were very positive about that learning experience, only 9% stated that the mentored research experiences led to the development of question-posing skills. Surprisingly, then, the findings from the present study suggest that research skill development embedded in regular courses has the capacity to be more effective in regard to developing question-posing skills than mentored undergraduate research models.

While 30% is a substantial proportion given the complexity of question framing, it is intriguing that 9 of the 10 course questionnaires in Table 1 showed statistically significant improvements in students' perceptions of this skill. Initially, one would expect that such an almost unanimous finding would be corroborated with a higher proportion than 30% of students noting the development of question posing as a skill in interviews one year later. Further research is needed to determine to what extent a lack of explicit (or implicit) development and/or assessment of a skill in subsequent years may allow skills to atrophy, or at least diminish in importance, in students' minds. The result lends weight to an argument for research skill development to occur in consecutive courses of the undergraduate years (Boyer Commission, 1998) to enable skills to reinforce, rather than to atrophy. The findings are in agreement with discipline-specific studies in regards to explicit development leading to improved research skills (Chaplin, 2003; Hoskins et al., 2007; Luckie et al., 2004).

Advantage 3: research skills useful for employment

In considering advantages of explicit research skill development other than specific skills, a substantial majority (89%) of students stated in interview, as recorded in

Table 2, that those research skills they learned in RSD-based courses were useful in work contexts, in agreement with a discipline-specific study (Peirce et al., 2009). Salient, however, is that only 24% of students stated that research skills would make them more employable. Students' long-term perceptions are that in RSD courses they developed research skills that are applicable to their working life, but not so useful for *gaining* employment. Research is needed to determine the usefulness of research skills in employment, especially including employers' perceptions.

Advantage 4: research skills useful for subsequent study and research

Of interviewed students, 75% stated that research skills explicitly developed in RSD courses were useful in other university courses, however only 9% of students stated that curricula of other courses helped develop research skills. The disparity highlights the benefits of making research skill development explicit in coursework, compared to skill development that is left implicit or not done at all. These results are in keeping with a study that deduced from interviews with academics potential advantages for students when connections between teaching and research are made explicit (Krause, 2008).

Of students interviewed, 37% stated that the explicit development of research skills in their RSD-based courses sparked their interest in further research and the same percentage said that it would help them to fulfil higher levels of tertiary study. This suggests that explicit research skill development may be a realistic way of encouraging more students onto higher degrees by research, a critical finding if frequent anecdotal claims about plateauing Ph.D. enrolments and projected shortages of academics prove to be well-founded. The finding also provides another contrast with the undergraduate mentored study noted earlier, which found that such an experience played a role in confirming a desire to progress to postgraduate research, rather than re-orientating students in that direction (Hunter et al., 2007). Whilst the contrast is surprising, it is understandable, given that undergraduate mentored research models tend to pick high-performing students who may often have research trajectories, whereas the RSD courses are developing the research skills of all students enrolled.

However, the results are in contrast to the questionnaire data of Table 1, which detected no significant changes in interest in research, in any course (Item 11). It may be that a longer-term, considered perspective was necessary for students to comprehend what they had accomplished and for them to consider researching in the future. A future study that interviews students or runs focus groups in the same timeframe as the post-questionnaire may contribute useful understanding here.

Advantage 5: gains for academics

Academics indicated that, through the use of the RSD, they clarified many teaching and assessment processes. Even more striking was that academics clarified discipline research processes and fed back the clarification into their curricula. Some academics found that their work with students lead to changes in their conceptions of research in their discipline, and even to changes in their research agenda. This, along with the other four advantages, supports the Boyer Commission's (1998) assertion that '[i]nherent in inquiry-based learning is an element of reciprocity: faculty can learn from students as students are learning from faculty' (p. 15).

Research Question 3. What factors support student research skill development and what factors hinder its development in regular courses?

Students in the year-later interviews identified that many of the factors supporting their research skill development (e.g., feedback, clear purpose and forward planning) are within the control of teaching academics (67%) and a similar proportion (65%) of hindering factors (e.g., lack of clarity, complexity and lack of specificity) can also be controlled at the course level. While 87% of students indicated that the RSD processes provided useful feedback, many indicated problems: 37% expressed there was a lack of clarity around feedback and 33% noted that they did not use the feedback, with 15% stating both (with students often offering both positive and negative comments). Indeed the External Reviewer noted that it is critical to guide students in how to use feedback, rather than merely providing it (Nightingale, 2009) and this is a necessary focus for further research. Similarly, while 78% of students reported that the RSD structure helped to make the purpose of assessment tasks clear, 28% indicated that they found the marking criteria too complex and 7% indicated the criteria were not specific enough. Moreover, while 65% of students indicated in interviews that they were able to forward-plan for assessments using RSD-based criteria, 15% of students stated that they were not able to do so and 20% of students said that a lack of guidance of how to move between levels in the matrices was a hindrance to developing their research skills. In a related issue, while 46% of students stated that the RSD-based matrices helped them to work autonomously as their course progressed, 20% also indicated that the requirement to work autonomously was not what they expected and that they found it a hindrance. These figures demonstrate that even though academics can use marking criteria to articulate to students requirements that are otherwise often left implicit, there is no substitute for classroom dialogue about expectations, the meaning of criteria, practice in their use and facilitating student response to feedback.

Discipline-specific and generic factors

Statistically significant, positive change occurred in students' perceptions about their ability to research in the discipline (Item 2, Table 1) in all 10 courses, however, in 4 of these courses, students did not perceive commensurate improvements in their general research skill (Item1, Table 1). This implies that discipline-specific and general research skills do not necessarily go hand-in-hand from students' perspective and, as discussed above, that many factors facilitating student research skills were primarily within the course context. Therefore, for the six courses where both discipline-specific and general research skills were perceived to increase, it is more likely that improved discipline research skills led to improvements in students' perception of their general research skills rather than vice versa. The other four courses, in which students provided data that their self-perceptions of general research skills did not increase, require further analysis. For example, in-depth analysis of Business Law students' perceptions (Willison, Schapper, & Teo, 2009) indicated the possibility that strongly nuanced research skills, such as those required for researching aspects of tax law, are not necessarily perceived as enabling general research skills. The present study and the Willison et al. (2009) study may have implications for *when* in university studies research skill development is emphasised to enable the greatest benefit – possibly in courses with less specialised knowledge, earlier in degree programmes. Together, the studies support empirically The Boyer Commission's (1998) call for

research experiences to occur from the first year of university study. However, the question of the generalisability of results needs to be considered.

Limitations and generalisability

Despite the strongly positive overall findings, the hindering factors in Table 3 show that numerous students interviewed did not find the process as clear (37%), explicit (35%) or guided (35%) as they would like and for some it was too complex (28%) or unexpected (20%). The RSD as a guiding framework is not a 'silver bullet' for facilitating the development of student research skills, but implementation is potentially influenced by a broad range of factors, possibly including university, discipline, year level, lecturer characteristics, cohort characteristics and degree of fit-to-context.

Moreover, it is problematic to generalise results of this study, even though it was conducted in a variety of disciplines, universities and year levels. The project team members could be characterised, by and large, as 'early adopters' or 'first- and second-generation innovators', their use of the RSD, therefore, may not accurately predict how the RSD would be used by the majority of academics when formulating teaching and learning. In addition, project academics have had substantial support, especially with the start-up of their RSD approach and writing of marking matrices.

Given the potential of cumulative benefits of using the RSD across multiple courses, studies in numerous contexts need to be conducted to determine factors that enable successful implementation of explicit research skill development at the degree programme level and the actual outcomes of programme-wide implementation. Adaptation of the RSD and consideration of appropriate implementation for each new context must be made to minimize any detrimental aspects of the resulting curriculum change and maximize benefits to students and academics, requiring time and support, especially in the devising phase.

Conclusion

From this study across multiple disciplines, year levels and universities, in courses run by academics who explicitly integrated student research skill development and assessment in the curriculum, there are five findings that are of contemporary relevance. The first finding is that students clearly perceived that they developed discipline-specific research skills and that these were useful for current or projected employment as well as for subsequent studies. The second finding is that a majority of factors that facilitated research skill development, as well as factors that impeded development, are within the control of course coordinators – students found academics' use of the RSD beneficial, yet also indicated problems in the implementation. The third finding is that research skill development may be better commenced relatively early in a degree programme, before students study courses where strongly nuanced research skills are necessary due to the specialization of content, and that incremental development over consecutive semesters thereafter needs to be considered. However, studies of outcomes of explicit and coherent research skill development across *entire degree programmes* are needed to confirm this. Such research should include student performance measures to complement other data sets such as questionnaires and interviews.

The remaining two findings of the study were unanticipated. The fourth finding is that explicit research skill development in regular courses has the capacity to be more effective than mentored undergraduate research in helping students develop question

framing skills and in encouraging students to progress to research degrees. The fifth finding is that academics indicated that facilitating explicit research skill development of students not only helped them clarify many curricular processes, but also stimulated them to reconsider the nature of disciplinary research and, in some cases, helped suggest new research directions. When these fresh understandings were fed back into the curriculum, a positive feedback loop was created between their teaching activities and discipline research. Taken together, the five findings of this study indicate that explicit research skill development integrated in the curriculum enabled academics' teaching and researching trajectories to converge.

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Note

1. The final report of this study and many discipline-specific examples of how academics modified assessments to facilitate research skill development are located at http://www.rsd.edu.au

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