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RESEARCHING, IMPLEMENTING, AND EVALUATING INDUSTRY FOCUSED AND CROSS-DISCIPLINARY DOCTORAL TRAINING

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ABSTRACT

Aim/Purpose	This article reports on university-funded research conducted to inform, design and implement applied industry-integrated training that could support higher degree by research (HDR) candidates in the disciplines of nursing and creative arts.
Background	Doctoral candidates contribute in steadily increasing numbers to the intellectual and economic capital of universities globally, however, the quality of candidate progression and outputs has also been widely criticised. How to best support doctoral candidates for success is therefore a critical focus for universities and an ongoing area of research.
Methodology	The study was framed as an action research project as it was driven by the identification of a problem embedded in professional practice that invited action and reflection as well as participation from other practitioners in the field.

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Contribution	This article presents a multidimensional, industry-focused model for HDR training that effectively engages HDR candidates with key threshold concepts for research.
Findings	Doctoral training needs to be more holistic, integrative and career-focused to meet the needs of increasing numbers of candidates with diverse backgrounds and post-doctoral career pathways.
Recommendations for Practitioners	This article provides a doctoral training model that can be adapted to other disciplines and industry contexts.
Recommendations for Researchers	This article provides a doctoral training model that can, and should, be adapted to other disciplines and industry contexts in order to build more substantive and reliable evaluative data.
Impact on Society	As secure career pathways in academia are diminishing, while the number of doctoral candidates are increasing, the integration of industry partners and applied contexts into holistic doctoral training is critical for the working futures of doctoral graduates.
Future Research	Further implementations and evaluations of the training workshop provided in this article would advance understandings of training design and implementation options and issues.
Keywords	higher degree by research (HDR) training, doctoral training, doctoral support, action research

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INTRODUCTION

Doctoral candidates contribute in steadily increasing numbers to the intellectual and economic capital of universities, yet the quality of candidate progression defined by such milestones as successful confirmation in year one, ethics application approval, satisfactory bi-annual progress reports (Berger, 2008; Gokhberg, Shmatko& Auriol, 2016) as well as the quality of research outputs, including the adequacy of sampling, data anlaysis and theorised research question development (Borders, Wester, Fickling, & Adamson., 2014), have been criticised. In addition, the fitness of doctoral graduates for employment in relevant industry settings, such as counselling (Borders et al., 2014), the creative arts (Webb & Brien, 2008; Webb, Brien, & Burr, 2012) and STEM (science, technology, engineering, mathematics) industries has been criticised (Field & Holmes, 2016). In a context where scholarly careers in faculty are increasingly scare in Australia (Jackson & Michelson, 2015) and the USA (Berger, 2008; Field & Holmes, 2016), career planning and relevant skills development within doctoral study is increasingly relevant. How to best support doctoral candidates for career success is therefore a critical and urgent focus-question for universities and an ongoing area of research, particularly in the universities of Australia, the United Kingdom, the United States of America, Canada and New Zealand (Brien, 2005; Brien, 2006; Evans, 2011; Golovushkina & Milligan, 2012; Kroll & Brien, 2006; McAllister & Rowe, 2003). This practice-based article addresses this question by reporting university-funded action research conducted to inform the development, implementation and evaluation of higher degree by research (HDR) training that could support candidates in the disciplines of nursing and the creative arts. It provides a review of scholarly literature regarding current HDR candidate training and support options as conducted in Australia and informed by practices in the USA and the UK upon which Australian approaches to research higher degree programs and training options have been traditionally founded. It then presents findings from an expert symposium and focus-group interview of experienced Australian HDR supervisors held in relation to effective candidate training options. These findings informed the design and implementation of a training workshop entitled

Industrial Strength Research Training, which is also described and evaluated in this article. The aim of this article is to inform and model HDR training approaches that engage candidates in the integrative and complex conceptual work of planning research that responds to real world problems in their intended field of industry. Findings from this preliminary research are discussed, and recommendations for further research are offered.

LITERATURE REVIEW

Universities across the globe (but particularly the Anglophone universities from countries identified above) are working to develop and incorporate appropriate doctoral research training in the context of what is described as the massification and professionalization of higher degree by research (HDR) study (OECD, 2012; OECD, 2014; Walker, Campbell, Duff, & Cummins, 2016). The dramatic increase in the number of candidates undertaking these degrees (both the traditional PhD and the Professional Doctorate are referred to in this article as HDR) has been estimated by the OECD (2014) at thirty-eight per cent since 2000. It is important to note that the increased enrolments in HDR study has occurred within this university sector that has become increasingly dependent on casual labour (Kimber, 2003; Ryan, Burgess, Connell, & Groen, 2013) and has not increased the numbers of tenured research-active academic staff qualified to supervise HDRs in response to these increased candidate numbers (Crimmins et al., 2016; Forsyth, 2014; Hamilton, Thomas, Carson, & Ellison, 2014). In Australia, moreover, there has also been increasing emphasis on timely completion by the Government which supports the cost of delivering these degrees (Watt, 2015). Needless to say, the pressure on universities, research units, faculties/schools and academic staff to adequately support an increasingly diverse body of doctoral candidate has intensified.

In the USA, the traditional model of a Doctorate has followed the convention of completion of Masters by Coursework followed by doctoral study incorporating further compulsory coursework, whereas the Australian HDR model has proceeded from Undergraduate Honours followed by Masters by Coursework or Research, and then PhD by supervision. However, as the traditional Australian honours/Masters Research pathway – and its scaffolded model of research training – is becoming no longer the norm (Hamilton et al., 2014), provision of research training for HDR candidates is perhaps more critical in Australia than in the USA. Moreover, not only has the number of HDR candidates increased, the cultural, linguistic, educational and professional profiles of candidates have also diversified (Johnson, 2014; Brien, in press). As a result, large numbers of international students now enrol in doctoral research degrees along with increasing numbers of professional workers who may have suitable, and even comprehensive, content knowledge, but little pre-existing experience, knowledge or skills in either planning, conducting or theorising formal research projects. Whether, and how, industry is engaged in research degrees is also of considerable current concern (Roberts, 2018). For such reasons, the provision of more comprehensive research training, including the further skilling of supervisors working with such diverse candidates (Grossman, 2018; McCulloch & Loeser, 2016) has become an important priority for Australian higher education providers.

AN OVERVIEW OF THE AUSTRALIAN HDR TRAINING SECTOR

Currently in Australia, each institution that offers doctoral-level qualifications – and often individual faculties, schools and/or discipline areas – develop and deliver HDR candidate training at considerable cost and with a lack of consistency and quality assurance. In Australia, this cost has become clear and pressing due to government changes of funding arrangements for HDR study, as a result of a 2015 Review of Research Policy and Funding Arrangements (Watt, 2015), which means that university funding is now only provided upon degree completion. Recognising the piecemeal approach to research training, the recently disbanded Australian Government Office for Learning and Teaching (OLT) has supported many projects over the last decade that have focused on areas relevant to HDR training and support, including: HDR supervision and its pedagogy (Bruce et al., 2009; Hammond, Ryland, Tennant, & Boud, 2010; Harrison, 2014); supervision standards/quality (Baker, Buckley, &

Kett, 2009) and supervision support (Blass et al., 2014; Hamilton et al., 2014; Homewood, Winchester-Seeto, Mackaway, Jacenyik-Trawoger, & Reid, 2010; Maor & Fraser, 2015; Yarlagadda et al., 2013); doctoral candidates' academic history and experience (Boud et al., 2014; Kiley, 2011, 2013; Kiley, Bell, & Feng, 2013); specific discipline support (Colbran & Tynan, 2006; Webb & Brien, 2008); support appropriate to cross cultural contexts (Homewood et al., 2010); and thesis assessment/examination (Phillips, Stock & Vincs, 2009; Webb, Brien, & Burr, 2012). Such studies point to problems with generic doctoral training (Boud et al., 2014; Kiley et al., 2013), recommend enhanced provision of such training (Homewood et al., 2010), and have even set up support mechanisms for those responsible for such training (Boud et al., 2014).

Indeed, the number of significant Australian research projects investigating issues in postgraduate study that have been commissioned and funded through the OLT have been so numerous (27 in total to 2014) that a further report was commissioned to review these projects, and develop an overview report and a set of good practice recommendations from their findings (see Hamilton et al., 2014). This overview report confirmed that while postgraduate studies include coursework programs, the distinct complexity of HDR programs and pedagogies has ensured that the literature and projects commissioned by the OLT are predominantly focused on the research degrees themselves (Hamilton et al., 2014).

An ongoing OLT research project led by Australian National University (Kiley et al., 2013) has involved an online survey of HDR candidates at five Australian Universities (n: 724) and reports a growing trend for Australian universities to incorporate coursework in HDR programs, with strong candidate support for this option (57%) (Kiley et al., 2013). However, the report also identified both high and low levels of candidate satisfaction with the research training that was offered to them. There are also conflicting views on the form that effective graduate research training should take: structured and formal as in coursework; or open and flexible, embracing work-integrated learning, cognitive apprenticeship and learning of related concepts and skills (Cumming et al., 2009). The most strident call for reform in research training is associated with providing integrative, holistic, interdisciplinary and career-focused training (Australian Technology Network of Univerisites, 2017; Cumming et al., 2009; Luca & Wolski, 2013). In Australia, a comprehensive review of the national research training system (McGagh et al., 2016) has identified several areas of strength, including flexible pathways and academic outputs, but notes that industry engagement is weak and calls for increased industry linkages during research training. A growing trend to outsource the provision of research training to professional training organisations is one response to the pressures put upon university research departments in this regard, but this strategy is considered a lost opportunity to nurture and develop upon the knowledge generated through training activities within an institution (Lia, 2011).

The Australian OLT commissioned report *Higher Degree Research Training Excellence: Good Practice Framework* (GPF) (Luca & Wolski, 2013) provides a comprehensive set of recommendations and resources, with training articulated across nine high-level dimensions essential to research training and their associated components. These include generic and transferable skills (such as literacy skills), critical thinking, research-specific skills (such as ethics management) as well as technical and professionally relevant skills (such as in computing applications, career planning and networking skills). A key objective of this Good Practice Framework is to address the variability of policies and procedures, including in relation to training, that is evident across Australian higher education institutions (Luca & Wolski, 2013). In the UK, but also influential in Australian universities, The Higher Education Academy (now Advance Higher Education), has similarly published a framework intended to develop and align professional standards in HDR supervision (Taylor, 2016). This Framework outlines areas of activity, professional values and core knowledge, as well as typical career stages for doctoral supervisors. Interestingly, "designing and planning learning activities" for candidates is the first criteria of five items (including "teach and or support learning"; "assess and give feedback"; "develop effective learning environments and approaches", and; "engage in continual professional develop-

ment in discipline and pedagogy" (Taylor, 2016). This prioritisation of designing and planning learning activities underscores the important role supervisors play in both identifying the training needs of, and providing solutions in relation to training for, their doctoral candidates.

Promoting Conceptual Integration: Using Threshold Concepts As A Pedagogical Rationale

While there may be some general agreement on essential content areas required in HDR training, the question of what constitutes the best pedagogic approach to training remains contested. It is generally accepted that training based on generic study skills offered in standalone sessions is inadequate as this emphasises the separation between academic practices and skills and the world of work (Lia, 2011; Porter & Phelps, 2014), and fails to acknowledge the interdependence of research problem and research method so critical to a study's validity (Trochim, Donnelly, & Arora, 2015). Figure 1. presents a chart devised by Trafford and Lesham (2009) that seeks to identify the components of 'doctorateness'; these authors emphasise that the difficulty for HDR candidates often lies in demonstrating these component knowledge/skills areas in *integrated* application, an integration that cannot be offered by compartmentalized, generic skills training.

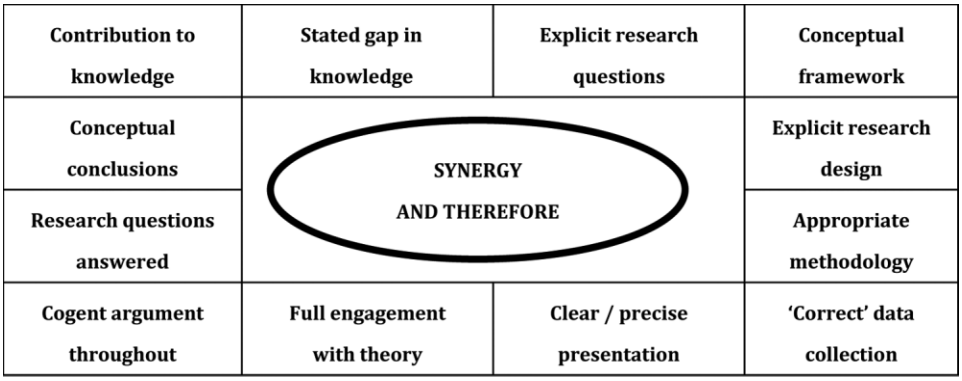

Figure 1: Components of 'doctorateness' (Trafford & Lesham, 2009).

Regardless of discipline, candidates also tend to struggle at pivotal academic points which resonate with generic threshold concepts in research – argument framing; theorising; research framework development; knowledge creation; analysis and interpretation; and, paradigm building (Kiley & Wisker, 2009) – and these pivotal points are not always successfully addressed within the candidate/supervisor relationship (Bruce et al., 2009; Bruce & Stoodley, 2013; Hamilton et al., 2014; Platow, 2012; Yarlagadda et al., 2013). These are, moreover, academic issues and concerns that need to be addressed by academic learning and teaching, rather than generic/generalist training and approaches (Costello, Waehning, Reed, & Shaw, 2014; Craswell, 2007).

In order that the *integration* of these knowledge and skill areas is developed by candidates and can be reliably evaluated, a training framework that adopts the notion of 'threshold concepts' rather than discrete skill sets is proposed for the design of research training (Trafford & Lesham, 2009). *Threshold Concepts* is a term developed by Meyer and Land (2003; 2006) and refers to new knowledge that is irreversible and integrative, and which is bound by application to a specific set of ideas or concepts, and is potentially troublesome as it raises new and unfamiliar issues (Meyer & Land, 2003). Threshold concepts represent "a gateway to learning and understanding through which candidates have to pass but where they may encounter real difficulties of learning and understanding" (Trafford & Lesham, 2009). As such, the notion of threshold concepts can serve to express the integrated conceptual, technical and professional skills and knowledge that candidates need to achieve, and also act as criteria for the assessment or evaluation of such learning as it is achieved through research training. Doc-

toral training that is devised to promote and support such integrative learning opportunities for candidates recognizes the importance of *process, purpose* and *impact* in addition to the more conventional emphasis on the empirical, original *product* in the developmental, scholarly journey to achieve 'doctorateness' (Sharam & Foroozan, 2018).

Promoting Industry-integration

In a recent review of the scholarly literature (from 2010 on) (Roberts, 2018) pertaining to Australian doctoral training programs, conflicting views on the work-readiness of doctoral graduates were noted (see for example De Grande, De Boyser, Vandevelde, & Van Rossem, 2014; Roach & Sauermann, 2010). In contrast to this, the literature conveyed a consistent emphasis on the need for collaborative (industry-university) doctoral programs that facilitate "an interplay between original research and developing sophisticated skills useful in the workplace" (Bogle, 2015). Roberts (2018) reports evidence from the literature that "a continued commitment to the development of programs which recognize the converging similarities and interdependencies of research and industry is valued" (p.542). Roberts also notes that providing opportunities for doctoral candidates to "realize their potential to apply skills in different contexts, where creative thinking and critical analysis" is more than important, it is "essential" (p.541). However, Roberts also reports calls for PhD program initiatives (and associated research) that "encourage industry engagement" to contribute to an enhanced understanding of what best practice in doctoral education may look like (Roberts, 2018). This study addresses this call for designing, implementing, evaluating and disseminating initiatives that both respond to, and seek to realize, the kind of industry-university collaborative research training that is theorized and prized but which is not yet strongly featured in the literature.

Summary

In conclusion, the imposition of a tighter structure within doctoral education is taking place in Australia and other Anglophone country universities, in order to achieve the following critical outcomes: better alignment of the doctoral experiences of candidates both nationally and internationally allowing for quality-assured equivalence as well as coherent program evaluation; support for the workload already borne by academic supervisors; and the achievement of more work-ready graduates with the capacity to engage across industries. This process has been described as the development of a generic doctoral curriculum (Green, 2009) and also described as a "transdisciplinary doctorate" (Mitchell & Willets, 2009; Walker et al., 2016). Furthermore, increasingly in Australia (as highlighted by the aforementioned Australian Council of Learned Academies report, (McGagh et al., 2016)), the integrative and holistic aspects of high-quality contemporary research training also now require the integration of industry experience and expertise, as well as an awareness of the issues and processes of other disciplines. As the number of tenured academic positions have declined globally, the likely career options and pathways for doctoral graduates have diversified and the integration of other contexts (such as industry) as well as other disciplines has become a focus for reform of research training to meet the career needs of HDR candidates (Australian Technology Network of Universities, 2017; Cumming et al., 2009; Porter & Phelps, 2014; Thune, 2009). This provides yet another challenge to research training, which we now address in relation to our study which, itself, responds to the lack of literature presenting applied training approaches that offer candidates holistic, integrative and career-focused research training.

Developing an Interdisciplinary HDR Training Project

In Australian universities, the career options available for doctoral and other HDR graduates of varied disciplines, as well as candidate employability in terms of these options, is shaping the research training made available within a research degree. A recognition of these career-focused needs informed this project, which sought to design a training workshop to support candidates from two dis-

ciplines that traditionally offer very different professional employment options for graduates with doctoral qualifications: the creative arts and nursing. These two disparate disciplines were chosen in order to provide a multi-disciplinary sample on which a cross-disciplinary approach could be tested and evaluated. Our project aimed to address this variability in research training available through Australian higher education providers by including academic experts from a cross-section of institutions and disciplines in collaborative identification of a range of academic threshold concepts for doctoral research, which can be implemented and evaluated through cross-disciplinary training. While the contemporary doctorate often seeks to promote interdisciplinary learning and engagement, it is noted in OLT reports on related topics that universities often poorly service this imperative (Hammond et al., 2010; Webb, Brien, & Burr, 2012).

A recent report from Council of the Advancement of Nursing Science in the USA (Henly et al., 2015) noted that: "Nursing science overlaps with the biological, behavioral, and social sciences at levels from molecules to societies considered in context and over time and that … interdisciplinary perspectives on health and health care have long been valued in nursing science" (Henly et al., 2015). Aside from recommending incorporation of extensive discipline-specific and profession-specific knowledge and skills to prepare graduates of Nursing doctorates for work in emerging areas of nursing science, the report also notes the need for "in-depth and interdisciplinary training in supporting areas of science content and method" (Henly et al., 2015). The Creative Arts discipline is distinct from Nursing in many ways, not least in terms of the very different career pathways and opportunities it presents to graduates. For example, it is now well established in the literature that initial and ongoing employment success for graduates of Creative and Performing Arts programs is particularly challenging (Australia Council for the Arts, 2010; Daniel & Daniel, 2013), underscoring the value of including industry engagement through work integrated learning within the doctorate itself. Together with this, it should be noted that creativity itself is a boundary-free attribute or endeavor, and the creative and expressive process can be applied in new educational contexts to positive effect because it is a so-called 'universal language' and useful generic skill. In the health-related disciplines, the positive influence of creative or expressive arts as therapy for trainee counselors, for example, has recently been documented, with the engagement with the Creative Arts functioning as a catalyst for turning discussion into feelings (Keller-Dupree & Perryman, 2013) and better attuning medical workers to the humans with whom they practice (Haidet et al., 2016; Rodríguez, Welch, & Edwards, 2012).

In this project, a number of opportunities were provided within an Australian regional university for Nursing and Creative Arts HDR candidates and their supervisors to interact regularly. Whilst shared learning activities took place and were evaluated positively, approaches to HDR supervision tended to be developed and take place privately and little common knowledge or practice was being shared across disciplines. Informal discussions with colleagues in other universities confirmed that such solitary supervisory practice was common and, indeed, rarely did Nursing and Arts candidates (or supervisors) interact. Thus, a project was designed to explore the lived experience of successful supervisors working across these knowledge boundaries, with the aim of expanding knowledge and developing methods to assist in the advancement of transdisciplinary, effective supervision and for industry-ready, or at least industry-focused, higher degree by research candidates.

Research Method

This research project was conceived as action research and aimed to establish a deep understanding of the lived experience in a defined and situated context through exploration and description of the lives of those involved in the research (Creswell, 2007; Denzin & Lincoln, 2011). Action research is a form of qualitative research that emphasizes not only wide participation and collaboration between researchers and researched, but also action that is undertaken to address a problem or situation (McNiff & Whitehead, 2002; Reason & Bradbury, 2008). Action research proceeds on the assumption that practitioners (in doctoral education, in this case) are able to improve their practice by seeking to better understand their candidates and taking action informed by research of themselves and

their candidates to address problems and then evaluate their actions in a cyclical process of investigation, action, critical reflection and evaluation (Efron & Ravid, 2013). Unlike traditional scientific research deploying either quantitative or qualitative methods, action research is particularistic – that is focused on exploring the experience and its impact for a particular group of participants and thus generalizability and replicability are not relevant (Efron & Ravid, 2013; Denzin, 2015). By undertaking the cyclical and reflexive process of inquiry that characterizes action research (Somekh, 2006), empowerment of participants and social change (Somekh, 2006; Townsend, 2013) are possible. The study was, therefore, framed as an action research project as it was driven by the identification of a problem embedded in professional practice that invited action and reflection as well as participation from other practitioners in the field (McNiff, 1993) (see Figure 2).

Action research was also suitable for this project as it is commonly conducted in education (Ferrance, 2000; McNiff, 1993; Singh, 2013) and in health settings (Koshy, Koshy, & Waterman, 2011). Riel (2017) states that, as designers and stakeholders, action researchers "work with their colleagues to propose new courses of action that help their community improve work practices" (Riel, 2017), and, as researchers, they "seek evidence from multiple sources to help them analyse reactions to the action taken" (Riel, 2017). The action research model encourages a problem-solution to be collaboratively proposed, implemented and then evaluated (Owens, 2005). In the case of this research, a collaboratively informed and designed, cross-disciplinary HDR training event was proposed, designed and implemented in order to better engage research candidates with a series of threshold concepts identified as critical in doctoral study. (It was also evaluated, as below.) These threshold concepts were: the identification and use of appropriate methodology; design of explicit research questions; and, identification of the contribution to knowledge.

Figure 2: The action research cycle
(this diagram is adapted from Coughlan and Coghlan, 2002).

The research process started with a desktop audit of university training provisions evident from the website of each institution in Australia that offers HDR study, and a review of the literature available on HDR training. In order to develop a complex understanding of the 'problem', that is, the training needs of current HDR candidates in Creative Arts and Nursing, it was necessary to further explore the current practices, successes and limitations of HDR training from the perspective of expert practitioners across a number of universities and exploit these experience-based insights to inform the (speculative) design of an effective training workshop. A purposeful sampling approach was adopted as the required characteristics of informants were that they were highly knowledgeable and experienced in HDR research supervision and training in fields of either nursing or creative arts, that is, they were experienced in the phenomenon of interest (Creswell & Plano Clark, 2011). In order to ensure an efficient recruitment of willing, as well as qualified, informants the lead researcher wrote

letters of invitation to six colleagues at six Australian universities who were involved in HDR supervision in Nursing or Creative Arts, all of whom accepted. In this day-long 'expert symposium' participants were provided with a summary report of the literature/sector review and asked a series of three questions (see Results section) that required them to reflect on, and then engage with, in group discussion format, their successes and struggles in supervision as a means of defining doctoral threshold concepts (or 'ah-ha' moments) both more fully in the Australian context, and on the basis of individual practitioner evidence. This entailed a discussion of flourishing and struggling candidates, and the identification of a series of successful training interventions (actual and hypothetical) from the perspective of supervisors. Data was collected by a note-taking assistant, audio-recording of summary reports from discussion groups and white board noting/photographing of key points made in answer to questions. Data was analysed to seek key themes and representative comments from participants in answering these questions. The design of the Industrial Strength Training Workshop was completed in this symposium and was supported by all participants as a good practice model that should be trialled with HDR candidates.

The next 'action' phase of the project involved the development and implementation of a one-day interdisciplinary HDR pilot training workshop that brought together industry professionals (one drawn from Nursing and another from Creative Arts), HDR candidates and supervisors. This training workshop was developed and implemented at the Noosa (Queensland) Campus of Central Queensland University, Australia, on 29 July 2016. It was a half-day activity (3.5 hours), which included lunch for participants. The resources required were: the facilitator; a meeting room and break out spaces; HDR candidates of different disciplines; HDR supervisors of different disciplines; two discipline industry-based experts; a simplified summary list of possible research methods/tools in social sciences; stationery; and, lunch. This training workshop was attended by 16 participants including ten HDR candidates, two leading industry professionals (Nursing and Creative Arts) and four experienced, senior HDR supervisors.

The workshop was devised to be interactive. Candidates were asked to listen deeply to an industry problem posed by each of the experts, to ask probing but respectful questions, and then, working in multi-disciplinary teams of candidates and supervisors, to devise a research approach that would explore this problem. The rationale, design and protocol for this training is reported and discussed below.

The HDR candidate training workshop was evaluated through a before- and after-training implementation of a survey incorporating quantitative (Likert scale) and qualitative (open-ended) questions. These questions were formed on the basis of common issues confronting candidates identified by the Expert Symposium attendees and deemed relevant to generic academic research threshold concepts (See Figure 1). These questions required the 10 participant HDR candidates to rate their confidence across the following concepts: identifying research problems, developing research questions, identifying appropriate research methods, team formation, budgeting and producing a research proposal. A single, open-ended question required candidates to identify their expectations of the training event and to comment on the degree to which these expectations had been met at the end of the training workshop. A survey was selected as the best method for collecting evaluative data from workshop participants as it provided anonymity, could be easily repeated and could establish quantified data, (as well as provide qualitative comments), upon which the authors intend to build by further iterations of the training workshop. As the initial training workshop involved only

Data obtained from before- and after-training surveys were assessed quantitatively using Statistical Package for Social Sciences (IBM, SPSS; version 22) and the open-ended questions were thematically analyzed using NVivo (QSR International Pty Ltd.; Version 10, 2012) software. For the quantitative analysis, descriptive statistics of the data, correlations between the questions (considering each question as a variable by itself), and comparison of the data before and after the training session were examined. In the qualitative analysis, a thematic analysis of the open-ended questions before and af-

ter the training was carried out. The reflective aspect of the action research is presented in the discussion of findings and emerging implications section of this article.

Research Results

The study led to new insights about student needs and the development of an interdisciplinary research training workshop.

Seven senior academic staff participants in the expert symposium responded to the following questions in a group discussion format.

1. What was a memorable moment from your own PhD or a recent research project that constituted an epiphany?
2. Can you discuss the features of candidates who flourished and those who struggled?
3. What were your most effective training interventions?

Responses were transcribed in note form, collated and then shared with informants after the event to ensure accuracy and encourage further clarification where appropriate. The seven participants are de-identified as ES (Expert Symposium) 1-7.

Threshold concepts

Each participant identified a critical moment in their own learning journey that changed the way they thought about research and practice. For some, this occurred within the degree and was focused on methodological problems and research questions as exemplified in the following comments:

> There was a moment when I was able to describe how the two parts of my thesis [exegesis and creative work] fit together in two paragraphs – only 6 months before I submitted (ES 5)

Others reported breakthrough moments within the degree related to significance or contribution to knowledge.

> When I was writing up I was starting to get doubts about the significance of my project. I was talking about that to my supervisors but came to realize that the strength of qualitative research is in the particular rather than the universal – a fine microscope/lens view of things is worthwhile. (ES1)

For others, the realisation of the significance of their doctoral research occurred once the doctoral journey was completed:

> I was in Australian Literature and it seemed meaningless at the time. However, recently, a student tapped me on the shoulder and said that I had changed research in this area. I wish there was someone around at the time who could have told me that my research was worthwhile and fundamental. (ES7)

These critical moments constitute potential threshold concepts – or learning turning points that other research students would benefit from learning. They include learning appropriate methodology, explicit research questions and knowing how they will make a contribution to knowledge. These insights parallel what Trafford and Lesham (2009) recommend as being appropriate at the doctoral level.

To flourish or struggle?

Participants identified that struggling candidates may: have inadequate undergraduate grounding in a discipline; demonstrate a resistance to methodology and associated theorisation; experience a poor interpersonal fit with a supervisor; and, experience the vagaries of financial, health or family devel-

opments. These various experiences were those that were identified to inhibit progress over the doctoral timeline of three- to four-years, or more.

On the other hand, flourishing students were identified as those who may: come from a strong disciplinary and/or research background; embrace the challenges of higher degree research and its intellectual and theoretical demands; and have developed interpersonal skills and relationships, including with supervisors. Additionally, it was noted that flourishing students tended to have a strong grasp of their research question, their topic of research, and its 'real-world'/professional/industry validity, significance and applicability.

Effective training approaches

Several novel ideas about effective training approaches were shared in discussion following this identification. For example, four participants suggested the benefits of organising and structuring peer-to-peer conversations about the research topic and research process, in both face-to-face mode and also through a webinar or teleconference format.

Another participant discussed the benefits of using strength-based questioning drawn from Narrative traditions such as to ask a student, 'If a miracle were to happen overnight, how would your literature review be composed differently to be compelling?' (ES2). This solution-focused communication strategy was effective in addressing procrastination.

A new workshop approach to research training

A key insight from the interviews was that students who flourish have a good understanding of the connection between their research and practice. Thus, the group collaborated to design and test an approach to research training that made industry relevance a key aspect. Thus, the workshop came to be called *Industrial Strength Research Training*.

Rationale

Doctoral candidates need to be able to respond to complex, real-world problems by practicing conceptually complex and integrated thinking, and by applying effective methodological strategies and generic skills in order to succeed in their studies and their careers. The *Industrial Strength Training Workshop* aimed to apply the findings from the expert symposium in supporting the abilities of candidates to negotiate threshold concepts (research method, research questions and contribution to knowledge) considered most critical to doctoral success. The training workshop sought to provide a holistic, integrative, career-focused, collaborative and interactive learning experience by bringing candidates together from different disciplines, engaging industry leaders and structuring the learning around complex industry problems that required integration of conceptual fields (iterated as threshold concepts) critical to effective research.

Workshop protocol

Preparation: Invite two industry 'high flyers' of different disciplines (Creative Arts and Nursing), to present to HDR candidates and participating supervisors on a current and complex problem that 'keeps them awake at night' in their professional practice/industry sector (15 mins per speaker).

Step 1: Solve my critical problem: After a brief introduction on the aims of the day (2 mins), one industry 'high flyer' presents a current and complex problem in their professional practice/industry sector to HDR candidates and participating supervisors (15 mins). Candidates question the presenter (10 mins) to access further information to better understand the problem and who is affected by it, as well as take notes on background information required to develop a research approach that can adequately frame and investigate the problem. Candidates then break into mixed discipline groups to brainstorm how to investigate this problem. For each of the industry problems, these groups then attempt to:

1. Identify and express the core problem/issue
2. Develop a research question that captures the problem
3. Propose a methodology that can answer the question within the practical constraints of the professional context over a research period of six months
4. Define (and distinguish) a research sample and a population
5. Explain expected research benefits
6. Identify risks as well as limitations to this research approach
7. List some potential personnel/requirements/items for research team and budget
8. Prepare a five-minute presentation on their research plan (30 mins)

These tasks were devised in order to address the most challenging threshold concepts identified for HDR candidates by the expert symposium (research methodology, explicit research questions and contribution to knowledge) – maintaining a constant focus on industry needs and contexts, and emphasizing the integrated nature of problem, method and applications to context.

Step 2: Pitch research solutions across discipline: Each team now pitches their research proposal to the professional speaker (5 mins each team) who makes notes and provides feedback to each team, identifying strengths and drawbacks where possible (total 20 mins max). The whole group then discusses the benefits and limitations of developing research approaches in teams, and across disciplines (10 mins).

Steps 3 and 4: Solve my critical problem, take 2: Repeat Steps 1 and 2 with the other industry professional, but with slightly briefer time allowance, to practice and embed learnings from Steps 1 and 2 (45 mins).

Each industry leader decides which project best fulfills their needs, and describes why.

Step 5: Reflections on candidate research planning: Individuals reflect on the problem that they are currently working with for their doctoral research. They should note down a research question, propose a methodology, define sample and population as well as benefits and risks. (10 mins). In cross-discipline pairs, candidates then explain the research problem they are developing for their PhD. They should also articulate their planned research approach and seek feedback from their partner. Partners should seek to identify a strength about the proposed research and something they are uncertain about or consider problematic. They swap roles and repeat. (10 mins). Each pair reports to the whole group on the major revisions or developments they have gained from the day in relation to planning their own research. (20 mins).

Step 6: Evaluation: All participants, including professional experts and supervisors, then complete an evaluation of this training session at the end of the day.

Workshop Evaluation

The workshop was attended by sixteen participants including ten HDR candidates, four HDR supervisors and two senior industry leaders all drawn from the discipline fields of Nursing and Creative Arts. Only the ten student participants completed the survey evaluation of the training. A survey on research confidence, comprising 6 items ranked on a five-point Likert scale and open-ended items was administered to the ten students before and after the workshop.

Quantitative results

Descriptive statistical characteristics of the scale score on a five-point Likert scale before training (see Table 1) show that participants already felt quite confident about the research issues explored. For example, understanding of problem identification was relatively good (M = 3.60, SD = 1.07). The

lowest confidence rating was given to selecting research methods (M = 2.90, SD = 1.29) and budgeting (M = 3.10, SD = 1.29).

Table 1: Workshop evaluation.

	Pre		Post	
Items	Mean (n:10)	(SD)	Mean(n:10)	(SD)
Problem identification	3.60	1.07	4.00	0.82
Developing research question	3.20	1.14	4.00	0.82
Selecting methods	2.90	1.29	3.70	0.95
Forming a team	3.70	1.49	4.20	1.03
Budgeting	3.10	1.29	3.50	1.35
Producing proposal	3.40	1.35	3.90	1.19

An analysis of variance was carried out to see whether the changes between respondents' perceptions before and after the training reached significance ($p < .05$). The result showed no significant differences were achieved.

The quantitative analysis revealed that although there was a notable increase of confidence among the participants on all issues in question, the increase was not statistically significant. Of course, the small sample size of ten, restricted the capacity of quantified outcomes to achieve significance in changes evident pre-training and post-training. While the changes in candidate confidence related to specific research concepts did not reach statistical significance, the changes in standard deviation between the pre-training and post-training survey responses indicate that before the training there was greater difference or distribution of opinion than after training. After training, the opinions were slightly more positive, and more aligned (especially on the first three items). No-one felt less confident as a result of undertaking the training workshop. These statistical results represent only a slim baseline of quantified data that the authors intend to build upon through continued testing and surveying. As might be expected for such a small sample size, the richer data from the training was in qualitative form.

Qualitative findings

Thematic analysis of the open-ended question before the workshop that asked what did participants expect to learn, revealed six themes: students expected to understand risks in research projects, develop effective research questions, learn about different methodologies, learn about how the academy and industry can work together and to brainstorm ideas to approach the research. Following the workshop students were asked to comment on how satisfied they were with the experience and what aspects they found to be most effective. The frequencies of their comments in relation to specific gains that they identified (not aligned with their pre-workshop expectations other than on the criteria of 'methodology') are presented in Figure 3. Clearly, there was strong satisfaction with the experience and participants particularly commented on gains in exploring and understanding methodology, being oriented towards the future as researchers, growing confidence as researchers, and the value of critical thinking.

The following comments were typical: "My expectations were exceeded"; "Everyone was very open and it was a fantastic learning experience"; "Exposure to divergent [different disciplinary] ideas"; and, "People see micro vs. macro issues differently".

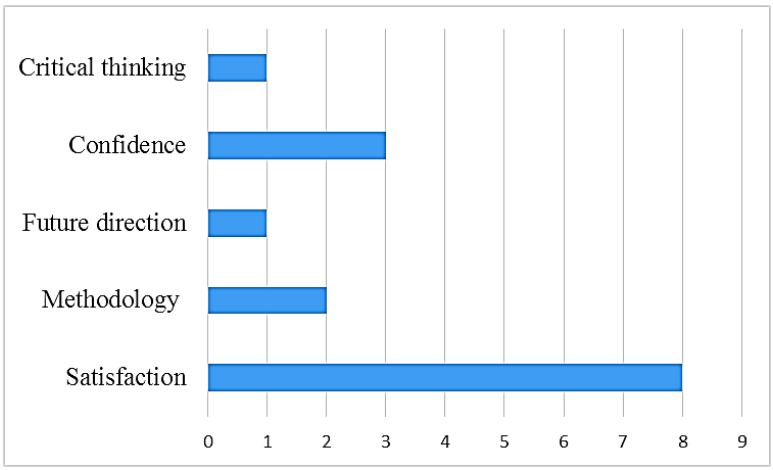

Figure 3: Post-training responses

DISCUSSION

This research sought to collaboratively design, implement and evaluate HDR candidate training that would provide a holistic, integrative and industry-linked training experience for doctoral candidates, as recommended in 2016 by the Australian Council of Learned Academics and other scholars (Cumming et al., 2009; Luca & Wolski, 2013; McGagh et al., 2016). The research adopted an action research approach that emphasised collaborative action and reflection in addressing and resolving a professional problem (McNiff, 1993). The first phase of the research involved an expert symposium of doctoral supervisors who identified key threshold concepts that doctoral candidates struggle with ('appropriate methodology', 'explicit research questions' and 'contribution to knowledge' (see Figure 1) and emphasised the need for training approaches that addressed these areas of challenge in collaborative, multidimensional formats that engage candidates with industry. The expert symposium contributed to, and endorsed, the design of the *Industrial Strength Research Training* workshop as an example of what such training might look like. The seven tasks for candidates provided in the training workshop were designed to support candidate abilities of recognising contribution to knowledge (Task 1, 4, 5), developing and explaining appropriate methodology (Task 3, 4, 5) and developing explicit research questions (Task 2), as well as to practice explaining or 'pitching' their own research to peers.

Preliminary evaluation of the candidate experience of the training workshop reported in this article requested feedback on the following concepts and skills: identifying research problems; developing research questions; identifying appropriate research methods; team formation; budgeting; and, producing a research proposal. In addition, trainees were asked to identify any other gains they felt they achieved from training in an open-ended question. Prior to training, candidates reported their lowest confidence level in identifying the appropriate research method, but it has been noted that the overall confidence of candidates was quite high prior to, and slightly higher after, research training across all question criteria in the survey instrument. Quantified outcomes from the survey indicate slight improvements in candidate confidence across the criteria, and less distribution of confidence levels across the cohort which, we acknowledge, is too small a sample to provide significant outcomes but can establish baseline data for further research. The qualitative comments received from the open question provided in the evaluation survey showed that satisfaction with the learning experience was very positive, and indeed there is considerable evidence that participants (candidates, supervisors and industry experts) found the experience highly energizing and inspiring. The opportunity to explore issues in a heterogeneous group was stimulating, and meeting with industry representatives made research seem real and relevant for candidates and supervisors. Candidates indicated that they had developed new learning around key threshold concepts and developed an appreciation of the con-

nections between academic research and industry. In discussion periods, debate between the candidates ensued, and many deeper questions about research including research methods were fielded.

These findings indicate that candidates welcome and benefit from a multi-dimensional, integrative and career-focused approach to doctoral training, which supports recent recommendations from the Australian Council of Learned Academics (McGagh, 2016) and findings from the literature review. This provides a potential area for future research. This approach to HDR training can address the following key challenges identified in the literature review:

- Pressure on academic staff in the context of increasing doctoral enrolments;
- Inadequate emphasis on industry-connected training;
- A need to provide more generic, transferable skills development and career planning;
- The limitations of a stand-alone, discrete skills HDR training approach that is common in Australian universities; and,
- The challenges candidates encounter in negotiating key threshold concepts of appropriate methodology', 'explicit research questions' and 'contribution to knowledge'.

The insignificant sample size is a limitation to the findings from this research, which it is acknowledged is a small-scale pilot project of a proposed solution to some key challenges encountered by doctoral candidates. Significant *improvements* in candidate confidence could not be identified due to a range of possible factors including the possibility that candidates already had strong confidence prior to the experience and this positivity was maintained, or that the experience was not sustained enough in terms of duration, and/or involved too small a sample for significant improvements to be measurable. The data collected in evaluating this project can only be considered preliminary, but it is hoped that the training model will continue to be implemented in new institutional and cross-disciplinary contexts, and that further data can be built to develop these preliminary findings.

As the research training agenda for doctoral programs in universities has only really developed over the last two decades (Deem & Brehony, 2000; Lia, 2011), it is not surprising that there remain inconsistencies and weaknesses across the sector (Webb, Brien, & Burr, 2012). A desktop audit of HDR training provision in Australia demonstrated the continued prevalence of such inconsistencies, but also reflected the concentrated efforts of Australian universities to develop and promote research training available for increasingly diverse HDR candidates who may not have prior research experience, and who may well develop industry-based career pathways outside of the traditional academic workforce. This research responded to the growing emphasis on the need to promote university-industry/business collaborations in doctoral study in Australia evident in the *Watt Review* (Watt, 2015) and the Australian Council of Learned Academies' Review of Australia's Research Training System (McGagh, 2016). Responding to such reviews, for example, the Australian Government now supports the Australian Postgraduate Research Intern scheme (formerly AMSI), which is expected to place many thousands of HDR candidates in three- to six-month paid work placements with industry (broadly defined). By such a range of strategies as the small-scale training workshop reported in this paper and the Australian national strategy of paid placements for HDR candidates, HDR supervisors and candidates can be better supported in the development of industry-integrated, high quality research that contributes to the knowledge economy as well as to the future careers of doctoral graduates.

CONCLUSION

This research project has highlighted the threshold concepts of "appropriate methodology", "explicit research questions" and "contribution to knowledge" (Trafford & Lesham, 2009) as being the most problematic aspects of HDR candidate practice and progress – initially from the supervisor's point of view, but also identified by training participants as troublesome concepts. While there are clear

external pressures to produce satisfactory outcomes from a research degree, including graduate employment and a thriving economy, and while the contribution of new knowledge flowing form doctoral research is important, there are a wide range of pressures that affect the completion of candidature that are not restricted to intellectual capacity and growth, and professional skill development. Ensuring a good candidate experience that leads to a successful completion is obviously important, but this research has proposed that providing networking/learning opportunities with industry experts and student peers from other disciplinary contexts, can also contribute to successful completions and influence candidates' decisions related to their research and career planning. The value of authentic peer-to-peer engagement as 'training' was emphasised, for example, by several informants, and as peer collaboration and feedback has been widely identified in higher education literature as a powerful factor promoting improvements in learning outcomes (Hattie, 2009; Biggs & Tang, 2011), designing highly collaborative and, where possible, cross-disciplinary training opportunities for candidates, is good pedagogy and can establish important peer support networks.

In conclusion, the aims of this project were realized in that expert senior academics across disciplines of Creative Arts and Nursing have collaborated to investigate and develop shared conceptual understandings of HDR candidate training needs. A pilot training workshop that responds to recommendations from scholarly literature in the field has been developed, implemented and evaluated. This training workshop has engaged industry professionals with junior researchers, established the value of interdisciplinary collaborations, and developed understandings of academic research threshold concepts. A pilot instrument that assesses HDR candidate confidence across relevant threshold concepts has been developed and tested, contributing baseline data on which both our and other universities may build through further training. The aim of this article was to inform and model HDR training approaches that engage candidates in the integrative and complex conceptual work of planning research that responds to real world problems in their intended field of industry. Further research in this area, including applications of the training workshop (or equivalent) in other institutions and across other disciplines, as well as more extensive evaluation of the candidate experience, is needed to better understand the benefits of such integrative, cross-disciplinary research training approaches, as well as to establish a valid and reliable research threshold instrument that could serve two purposes: as a self-assessment of learning needs in research candidates, and to evaluate the outcomes of teaching and learning experiences in research workshops.

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