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# Perceived Assessment Requirements in the Contemporary Biomedical Doctorate: A Case-Study from a Research Intensive Australian University

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## Abstract

The present work draws on semi-structured interviews with Ph.D. students and supervisors working at an Australian Group of Eight University and uses elements of constructive alignment as a lens to discuss perceptions of assessment requirements for a doctorate in the biomedical sciences. Herein, we identify **i)** significant ambiguity among students regarding their understanding of learning objectives and the criteria on which they are assessed, **ii)** a large degree of agreement between supervisor perceptions of assessment criteria and the stated assessment criteria, and **iii**) a perception (common to both supervisors and students) that publication of research findings is a key element of doctoral assessment. We suggest that improving the alignment of stated and perceived assessment criteria may assist socialising students to the doctoral learning environment and improve learning outcomes in the contemporary biomedical doctorate.

**Keywords**: Biological sciences, graduate study, doctoral degrees, doctoral programs, independent study, learning theories.



## Introduction

Over the past decade, research pertaining to doctoral education has been characterised by a growing appreciation for the complex nature of the doctoral learning environment and the multitude of ways in which students operate, both individually and collectively within it

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(Barnes, 2009; Cumming, 2009, 2010; Lahenius & Martinsuo, 2011). Simultaneously, ongoing concerns relating to minority representation, gender bias, non-completion, and the effect of contemporary developments in the higher education sector (e.g., funding constraints, casualisation of the academic workforce, and stricter bureaucratic oversight) on doctoral education reinforce the need for additional empirical studies to inform developments in this important and historically overlooked area of scholarship (Gardner, 2009b; Golde, 2005; Herman, 2011; Mansfield, Welton, Lee, & Young, 2010; Mendoza, 2007).

We elected to employ constructive alignment as a framework for the analysis of biomedical Ph.D. students' and supervisors' perceptions of assessment requirements derived from data collected in a series of semi-structured interviews undertaken at a Group of Eight (Go8, a consortium comprised of the eight top-ranked, research-intensive universities in Australia; www.go8.edu.au). Constructive alignment is a well-established model of curriculum planning and implementation, designed to promote understanding and clarity in learning and teaching objectives (Biggs, 1996; Biggs & Tang, 2007). We elected to focus on the biomedical doctorate due to **i)** our own involvement and familiarity with it (as both students and subsequently as supervisors) in doctoral education in biomedical sciences, **ii)** the existence of a large body of evidence suggesting marked operational and philosophical differences in teaching and learning processes between hard and soft life/non-life sciences and sub-disciplines therein (Golde, 2005), and **iii)** our observation that, to date, relatively few studies have looked specifically at perceptions of assessment in the construction and function of the biomedical doctorate. The primary objective of the present study was thus to perform an analysis of student and supervisor perceptions of doctoral assessment objectives, using constructive alignment as a theoretical framework.

Herein, we discuss findings drawn from a series of 18 semi-structured interviews with Ph.D. students (n=10) and supervisors (n=8). Drawing on contemporary developments in doctoral education (including restrictions on length of candidacy and the progressive adoption of submitting a thesis as a series of papers) we identify significant variation among students' understanding of curriculum objectives and the criteria against which they are assessed. Supervisors were found to have an accurate understanding of the stated assessment objectives. Interestingly, both students and supervisors reported a focus on publication as a requirement for the successful completion of a biomedical doctorate, despite this not being an assessment criteria at the institution at which this study was undertaken. We conclude by suggesting that better understanding of doctoral assessment criteria, combined with an increased focus on highlighting the differences between the mandated examination requirements for a successful Ph.D. (as stipulated in university examination requirements) as opposed what might constitute a successful Ph.D. with regards allowing the student to subsequently forge a successful career as a researcher in the biomedical sciences (i.e., multiple original research papers and conference presentations), may assist in improving learning outcomes in the contemporary biomedical doctorate.

## *The Contemporary Doctoral Learning Environment*

The past decade in particular has seen a steady increase in research activity aimed at bettering our understanding of the doctoral student experience. A range of factors are likely responsible for this development, including the increased understanding of research's importance to national competitiveness (Gupta, 2010), governmental attempts to regulate and audit doctoral learning processes (Brooks & Heiland, 2007), marked increases in doctoral student numbers and demographic heterogeneity (Barker, 2011; Nettles, 1990; Ulku-Steiner, Kurtz-Costes, & Kinlaw, 2000), funding constraints (Neumann, 2007), and ongoing concerns regarding the frequently high rates of attrition reported amongst doctoral students (Gardner, 2009b; Golde, 2005).

As a result of this and earlier research, it is increasingly apparent that the doctoral learning environment is both complex and, to a large extent, quite specific to the individual faculty and stu-

dent. A broad review of the field suggests that, in addition to features innate to the student (i.e. gender, cultural background, intelligence, socio-economic background), the extent to which a particular environment is effective in supporting doctoral learning is predicated upon the interaction of a host of student-centric factors including peer relationships, supervisory relationships, funding availability, perceptions of value, freedom and support (from both inside and external to the university), clearly defined study objectives and an intrinsic interest in the subject under investigation (Barker, 2011; Golde, 2005; Klenowski, Ehrich, Kapitzke, & Trigger, 2011; Lahenius, 2012; Lahenius & Määttä, 2011; Lunsford, 2012; Martinsuo & Turkulainen, 2011; Mendoza, 2007).

Gardner (2008) has argued that the concept of socialisation provides an especially useful tool to analyse the doctoral learning environment as it "affects every part of the student experience" (p. 126). To this end, a number of investigators have analysed themes of socialisation and culture in the doctoral learning environment as modernist constructs, wherein an individual (the doctoral student) undergoes a normative adaptation to the relatively constant culture of their academic environment (Gardner, 2009a, 2010; Golde, 2005; Hakala, 2009; Holley, 2009). This process is similar to that described by Tierney (1997), wherein "culture is the sum of activities in the organisation, and socialisation is the process through which individuals acquire and incorporate an understanding of those activities" (p.4). Research into doctoral socialisation, attrition, and outcomes have led to an understanding that for students' successful socialisation to the research and professional culture(s) particular to their discipline, department, and/or academic institution is an important determinant of success in doctoral education. Importantly for the present study, successful socialisation to a research culture has been shown to require, amongst other factors, a clear understanding of learning objectives and assessment criteria by both students and supervisors (Gardner, 2010; Golde, 2005; Gopaul, 2011; Hakala, 2009; Holley, 2009). The importance of clearly understood learning objectives and assessment criteria, combined with a lack of such data in the biomedical doctorate, precipitated us to undertake the present study.

## *Constructive Alignment*

Constructive alignment is a theoretical framework for curriculum development, delivery, and assessment, initially propounded by Biggs (Biggs, 1996; Biggs & Tang, 2007). The theory of constructive alignment is widely (although not uniformly) supported and has been applied to the analysis and development of teaching and learning in a variety of educational settings and disciplines including English language teaching, geography, computer sciences, business management, sociology, and radiography (Castle, 2006; Mavor & Trayner, 2001; Rust, Price, & Berry, 2003; Szili & Sobels, 2011; Teater, 2011; Thota & Whitfield, 2010). Functionally, constructive alignment marries phenomenographic studies into student learning undertaken by Marton and colleagues with the practice of instructional alignment, highlighting the constructivist elements of learning as a student-centric process (Cohen, 1987; Marton, 1981; Marton & Booth, 1997; Marton & Svensson, 1979). The practice of adopting psychological / philosophical models to learning in the sciences has not been without some controversy (notably in the field of chemistry), much of which appears to be due to a lack of clarity over the use of terms such as constructivism (including its various subtypes) and relativism (Bernal, 2006; Scerri, 2003). For the purposes of the present work, we regard recent commentary by Taber (2010) as providing useful clarification in this matter. Our use of constructivism refers to the theoretical cognitive process by which an individual is hypothesised to build his own knowledge (or perception of a particular phenomenon or subject), based upon a milieu of contemporary and *a priori* experiential factors. We do not, however, subscribe to the position that a constructivist view of cognition equates to a relativist perspective that knowledge is equally valid irrespective of its derivation (Scerri, 2003).

We suggest that assessment objectives are key to the practice of constructive alignment: the design and implementation of both curriculum assessment and learning environment being aligned

to the curriculum objectives. Or, as stated by Biggs (1999), "A good teaching system aligns teaching method *and assessment* to the learning activities stated in the objectives [emphasis added]" (p.11). In keeping with the phenomenological approach from which constructive alignment is drawn, we suggest that ensuring perceptual equivalence of what Knight (2001) terms the 'planned curriculum', the 'created curriculum' and the 'understood curriculum' are key to the operational implementation of constructive alignment. Simply put, if the student perspective (which we define as the understood curriculum, including that which is perceived as constituting assessment of said learning activities) does not accurately reflect the created or planned curricula (on which assessment is based in a constructively aligned model) then attempts to create alignment are, in a functional sense, likely sub-optimal and may result in confusion and mixed messages amongst students and staff alike.

# Materials and Methods

## *Ethics Statement*

Data presented herein derive from semi-structured interviews undertaken in 2012 with Ph.D. students and supervisors working in the biomedical sciences at one research intensive Australian University. These interviews form part of a wider Australian study investigating peer relationships, motivation (both dealt with in separate reports), and perceptions of assessment in doctoral students working in the biomedical studies. The studies described in this submission were reviewed and approved by the relevant institution's Human Ethics Committee. Informed consent was obtained, in writing, from each participant prior to research commencing.

## *The Use of a Semi-Structured Interview Model*

Students and supervisors were initially asked to describe the aims, objectives, and area of their research. Key interview questions for assessing perceptions of doctoral assessment requirements were the following:

**i**) What do you think are the key requirements for a doctoral thesis?

**ii**) What did you think a Ph.D. involved when you started and has that changed?

**iii**) What are the experiences that you think are essential for students in the field?

**iv**) Please discuss some of the issues you have encountered as a student.

**v**) Please describe your workload.

**vi**) Do time, funding, or other personal factors affect the research that you undertake?

Data were collected and analysed in line with consolidated criteria for reporting qualitative research (COREQ) guidelines (Tong, Sainsbury, & Craig, 2007). Students and supervisors were recruited to the study via invitations circulated across departmental email lists and by personal referrals. Informed consent was obtained in writing from each participant prior the interview commencing. None of the participants had a prior direct relationship with the interviewer and had limited understanding of the study outcomes prior to interviews (all participants were debriefed and given the opportunity to ask questions relating to the study at the conclusion of each interview). All respondents from biomedical disciplines were enrolled in the study. Seeking a sample size of ten students and ten supervisors, we subsequently enrolled **i)** ten doctoral students and **ii)** eight doctoral supervisors. Interview lengths were normally distributed for both students (40.0±8.0 minutes) and supervisors (37.0±13.0 minutes). Students (three male, seven female) and supervisors (four male and four female) were drawn from the following biomedical disciplines: oncology, human (musclo-skeletal) biology, reproductive biology, medical engineering, physiology, cellular and molecular (signal transduction) biology, pharmacology, and endocrinology. A

common feature of all students' and supervisors' work was a focus on employing research in their particular biological discipline to improve human health and prevent and/or treat disease. Two students were in the first year of their studies, four in their second year and four in their third year.

In an attempt to promote consistency, all interviews were conducted and transcribed by the same investigator. Interviews were conducted in a private room in students'/supervisors' departments. No enrolled participants refused to participate or subsequently withdrew from the study. The accuracy of transcriptions were checked against audio recordings by randomly accessing and reviewing three, ten second sections from each interview. Interview transcripts were coded using the Miles and Huberman approach to identify isolated and repetitive themes both within individual transcripts and across the sample set as a whole (Punch, 2009). A categorical list of these themes was constructed based upon the frequency of thematic identification across the data set. Interview transcripts were then re-analysed to investigate the perceived structure and importance of each individual theme to the construction of each student's learning environment. Care was taken to report both major and minor themes emerging from the data set.

## *Planned Assessment and the Contemporary Biomedical Doctorate*

The definition of the 'planned learning assessment' (against which student perception – or the 'understood learning assessment' – may be assessed) is of critical importance. The thesis (whether submitted as a series of papers or in the traditional format comprised of a collection of three to four experimental chapters supported by a comprehensive literature review and a final critical analysis of the thesis' findings in relation to the literature) was identified as the primary mode of assessment at the Go8 institution at which the study was undertaken. *Viva voce* was not employed as an assessment task. The institution in the present study accepted the submission of a thesis as a series of papers constructed from manuscripts that **i)** had been published, **ii)** had been submitted for publication (but not necessarily accepted), or **iii)** had the potential to be submitted for publication. In addition, it required an introductory chapter providing a critical review of the literature in relation to the thesis and a final summative chapter.

Our analysis of the planned learning assessment in the biomedical doctorate is based on the work of Kemp and colleagues (Kemp, Newnham, & Chapman, 2012), who have previously undertaken an assessment of the key thesis examination requirements (employed irrespective of whether a body of doctoral work is submitted for examination in the traditional thesis format, or as a series of papers / publications) detailed by university guidelines from research-intensive institutions in Australia and the United Kingdom. This analysis suggests that a body of doctoral work must represent a rigorously constructed, original, and substantive body of work that makes a contribution to the field under study in order for a student to obtain a Ph.D. These planned assessment criteria are well aligned with the examination guidelines published by the institution at which the present study was undertaken. In this investigation, we have used the planned assessment criteria described by Kemp and colleagues as a framework against which to analyse students' and supervisors' perceptions of assessment criteria in the biomedical doctorate:

> (1) the thesis makes an original and substantial contribution to the field in which the doctorate is based, by generating either new knowledge or allowing for the innovative re-interpretation of existing knowledge;
>
> (2) the thesis contains a sound general knowledge of the field in which the doctorate is based;
>
> (3) the thesis is based on work completed over a three to four year period of full time study (or part-time equivalent);

(4) the thesis is presented in a sound and lucid manner; and

(5) the thesis is genuinely the work of the candidate.

# Results

Use of [ ] donates editing of student or supervisor responses to prevent identification of individual respondents. Responses are presented as verbatim transcripts without correction for grammar or style.

## *Supervisors' Perceptions of Assessment Criteria*

Two predominant themes arose from our analysis of supervisors' perceptions of the assessment criteria applied to thesis examination: **i)** concordance of supervisors' perceptions with most specified constituents of planned curriculum assessment; and **ii)** an emphasis on the need for students to publish their work in peer-reviewed journals during candidacy.

### Concordance of supervisors' perceptions with most specified constituents of planned curriculum assessment

Originality, novelty, and a substantial contribution to the field (points one and three of the summary of stated thesis requirements) were identified most frequently by supervisors (seven of eight supervisors identified originality, novelty, and a substantial contribution in their response) as being key to meeting the assessment criteria ascribed to a biomedical Ph.D. thesis:

Supervisor A: *You need to be researching an original topic, there is no point merely replicating what someone else has done before. There has to, the data generated need to justify the three years investment. A thesis shouldn't be passed if it only has six months of data.*

Supervisor D: *Originality and the fact that it has contributed to a new piece on information. Original research. It might be building on something that has been done before and certainly we have examples here of that before, someone has done an original piece of research but the next phase of that is the next piece of original research.*

Supervisor E: *Strictly speaking it is an original contribution to knowledge in the field and substantial.*

Supervisor H: *Novelty is very subjective, I think if you look hard enough, most of the answers are already there, however it's how you are trying to answer it, how you are growing the field. You don't have to invent a new wheel – maybe make the wheel better.*

The stated requirement for a thesis to demonstrate a sound understanding of the field in which it was based was identified (point two of our summary of stated thesis requirements) by most supervisors interviewed. Supervisors identified a literature review as being an appropriate way of demonstrating mastery of a particular field.

Supervisor B: *Should be a scholarly body of work demonstrating mastery or at least an in-depth understanding of the student of their particular area. Which means that they can demonstrate they have understood the literature, interpreted it, assembled it, dissected and criticised it and hold their own in a conversation to defend their point of view.*

Supervisor D: *Investigating the literature fully so that they are aware of exactly what the gaps are so that their research does fill a gap in the literature so basing their premise and their hypotheses on a good sound literature review as to guide them to their direction in where they want to go.*

Supervisor G: *I am very keen on the writing aspect. It has to have a tremendous insight into the existing literature, be highly critical and put it in a wider context. I am a great believer in show-*

*ing why you are doing this in the sense over to the translational thing where one can. We are in vivo animal work predominantly, it is not just esoteric gene manipulation or signalling. So really a solid lit review.*

Presenting a coherent thesis submission and demonstrating an ability to analyse and interpret data in a lucid manner (point four in the summary of stated thesis requirements) was also identified by most supervisors as a key assessment criterion.

Supervisor A: *The ability to interpret the data and compare your findings to previous publications, and independent thought by the Ph.D. student in general.*

Supervisor B: *Thesis would need to demonstrate that the student is able to analyse his or her data within context and importantly discuss the strengths and weaknesses of their data and not over-interpret everything. I've read a lot of theses where the student presents every minor point of data as a hugely significant thing. I don't think that demonstrates a maturity of insight and scientific nous. I think they need to interpret what is real and what is potentially significant, interesting and also to look at spurious data and trivial or minor findings and say this probably doesn't mean anything and even if it does, it's not likely to be significant.*

Supervisor C: *They need to demonstrate a cohesive train of thought and that they have started with hypotheses and have managed to prove or disprove those hypotheses.*

## An emphasis on the need for students to publish their work in peer-reviewed journals during candidacy

The institution's stated curriculum assessment for thesis submissions (irrespective of format) did not stipulate a requirement for students to publish their work (or even submit their work for publication) during their candidacy. For theses submitted as a series of papers, its 'minimum requirement' was that they be presented in a format that could conceivably be published. The predominant supervisor perception (all interviewed supervisors referred to the importance of students publishing prior to completion) was that publishing during candidacy was a key requirement for a doctoral thesis, with the overt preference being for students to submit their thesis as a series of publications.

Supervisor D: *A series of publications as part of it. We do all of ours as thesis by publication with interlinking chapters.*

Supervisor E: *As this link between thesis and publication has become more overt with encouragement from [] to publish papers along the way, if you can, I mean a lot of people did that anyway. I had a Ph.D. student who graduated in [] who submitted as his thesis three publications, they were all good papers, as in they were A* journals, in my opinion it was a small thesis, but it went straight through. So three manuscripts out of a Ph.D. is considered quite good, certainly acceptable.*

Supervisor F: *Most of them do it by publication so they have a series of papers that they write as part of their project, usually a review of the literature at the beginning and hopefully two or three or more useful papers by the end of their project.*

Supervisor G: *I think nowadays our Ph.D. students, we are very much pushing them into publications to write a thesis up and I think it is in everyone's interest to do that. So a lot of our students will have three or four papers and a review or two.*

The perception that a student could submit work of a standard that *could* be published (at a later date) for examination (either as a thesis or as a series of papers) was uncommon in our cohort of supervisors, despite concurring with the Institution's stated thesis requirements.

Supervisor B: *Secondly, the findings of their research need to be novel, publishable and sufficiently important and significant to be able to be published.*

Supervisor C: *I don't have a preference whether a doctoral thesis is a collection of papers or a collection of chapters. It should be a cohesive body of work that explores a scientific or medical problem. I don't believe that the research itself needs to have successful outcomes because sometimes projects just aren't successful.*

## *Students' Perceptions of Assessment Criteria*

Student perceptions of the criteria employed in assessment of their doctoral work demonstrated significant variation in our interview cohort. Two predominant themes characterised student responses: **i)** striking levels of ambiguity in perceptions of the understood curriculum assessment criteria; and **ii)** the perception that positive results or having research published is a key assessment criterion.

### Ambiguity in Student Perceptions of Assessment Criteria

Uncertainty, coupled with an apparent reliance on second hand information were the prevailing themes identified in student perceptions of the assessment criteria applied to the examination of doctoral research. Several students expressed general ignorance of how their thesis submission would be examined.

Student B: *That's a hard question because I have never done a Ph.D. and I have only been doing a Ph.D. this year. So what I know is only what I have heard. And sometimes that is not accurate – the stories go round and round, and they might be urban myths*.

Student H: *So I think at the end of the day you do however much your supervisor says you can get away with. A lot of times it is more than you need to do. So I think the question of how much you need to do to finish is a bit of a hard question to answer.*

Student B was subsequently asked to elaborate specifically on what the [Institution A] might want her doctoral thesis to reflect: *Well that I don't know – and I wouldn't want to guess. At all. I think that's what I need to find out in another year's time – not at this stage. I don't think I can answer that with any certainty – that'd be a guess.*

The remaining students interviewed were able to identify varying combinations of the five points identified in Kemp and colleague's synthesis of doctoral assessment criteria, although only one respondent (Student E) referred to having read '*the actual outlines*' and was able to identify all five elements of the thesis examination guidelines. Novelty, making an original contribution, producing a substantial body of work and telling a coherent story were variously listed as being key criteria against which a doctoral submission was assessed.

Student A: *For doctoral work it has to be something that contribute to something. They require originality. Also for me it is like perseverance.*

Student C: *I think that you need to reflect your ability to investigate an area of research that may or may not have been known to you before. To a fairly detailed extent. And understand why there was a need to do further research in that area. Then implement that research analyse it and interpret it to increase knowledge in that area. I do know I do feel that you might not have to do all those parts unaided.*

Student D: *Firstly I would say an in-depth knowledge of the area and building on that an additional piece of knowledge or understanding that has not been in the literature. To really make it as basic, in its most basic form, adding something new to the literature or the understanding of that specific area.*

### Positive Data and Publication as an Examination Requirement

The majority of students interviewed reported that obtaining positive results and successfully publishing their research was a key examination requirement for a Ph.D. As discussed above, the institution's Ph.D. examination guidelines for a thesis as a series of papers stated that it was acceptable to submit papers that **i)** had been published, **ii)** had been submitted for publication (but not necessarily accepted) or **iii)** had the potential to be submitted for publication.

Student B: *Our department is moving towards a Ph.D. by the thesis as a series of publications with connecting chapters.*

Student D: *It gets drilled into you to publish or perish. You start to look at the calendar going, I'm half way though, I'm two-thirds through, how much have my peers published? How much have I? And it becomes quite a stressor point actually, to me I keep thinking of lists in my head of what I can publish and when and to me I would rank it as the most important thing to me and therefore the biggest stressor to me over the thesis itself, presenting research data at conferences, I put publications well and truly above those.*

Student G: *Ideally, I want to get the results that I want, to see an effect that the [treatment] will cause them to become [changed] and the [treatment] that I give them will prevent them becoming [changed]*.

Student H: *A lot of what happens in my lab with the Ph.D. students is, cos we usually submit by papers rather than one big thesis – so it's kind of "how many chapters have you done?" is kind of what we do. "Do you think that will be enough?" Because no one really wants to do more than they need to.*

One unifying theme from the above responses is that these students perceived publication as a summative assessment exercise that required positive data and characterised it as a 'pass or fail' process. Interestingly, a small number of students appeared to view the process of publishing their work as a type of formative assessment which provided motivation to continue in their work as well as a valuable source of constructive feedback that benefited the progress of their research and their development as scientists.

Student I: *I think the most learning experiences are from the incidental or the things that you didn't do, I think that is probably where you get the most learning from, when your papers get rejected and the comments come back and things and you sit there looking at them and go dear god, these reviewers are idiots or incredibly cruel, and you come back and look at them again and say, ok I'm not writing this style, for me it was really good in that it gave me that I have to take that step back and write from a more stepped away perspective rather than deeply involved in assuming everyone knows this and that, make sure it is a more general thing.*

## Discussion

Adopting constructive alignment as an analytical framework has allowed for the identification of two overarching themes in our cohort of student and supervisor interview responses: **i)** Ph.D. supervisors report an understanding of curriculum objectives that, with the exception of an apparent focus on the need to publish, are well aligned with the planned curriculum assessment objectives outlined in the examination guidelines published by their university; and **ii)** students shared their supervisors' misaligned focus on the need to publish during their doctoral studies. Overall, students predominantly demonstrated a view of curriculum assessment criteria that was poorly aligned with their respective institution's planned curriculum assessment objectives.

In the present study, the prevailing supervisory view of assessment criteria for thesis examination included most factors included in Kemp and colleague's five-point summary of key thesis exami-

nation requirements, with particular importance placed upon originality, novelty and substance (see responses from Supervisors A, D, E, H), a sound knowledge of the field (see responses from Supervisors B, D, G), and the need for lucid communication of findings (see responses from Supervisors A, B, C). The fifth point in our summary, that the thesis is 'genuinely the work of the candidate' was not specifically identified by any of the supervisors in our cohort, perhaps because the requirement for students to submit their own work, and explicitly acknowledge the input of others for assessment, is an implicit requirement of university assessment generally. Interestingly, the student perception of specific thesis examination requirements was frequently poorly aligned with both supervisor perceptions and the requirements detailed by the university itself. Several students in our cohort (see responses from Students B, H) were unable to identify one or more of the thesis requirements. One student (B) was, in addition to being unable to identify any of the likely criteria used to assess her work, surprisingly dismissive of the need to understand these requirements before at least two years of doctoral study had been completed.

The reasons underlying this apparent disconnect in alignment and the development of means by which it may be resolved constitute important future research avenues in this area. A substantial body of empirical evidence exists to demonstrate the utility of properly implemented constructive alignment in curriculum implementation to promoting student success (Biggs, 1996; Biggs & Tang, 2007). Furthermore, work by Gardner (2007, 2008, 2009a, 2009b) has demonstrated the importance of socialisation in doctoral success, with the successful attainment of knowledge and understanding of culture playing a key role in the socialisation process. With regards to doctoral socialisation, it is thus apparent that a clear understanding (from both student and faculty perspectives) of the roles and standards required of a doctoral student constitutes a key element of successful socialisation. Barnes and Randall (2012, p. 48) (citing work by Golde and Dore, Golde and Nyquist) have recently highlighted how a perceived lack of information and deficiencies in the common understanding of goals, processes, and expectations has the potential to negatively impact doctoral learning processes. Several studies have also reported shortcomings in doctoral learning processes deriving from unclear or poorly defined goals and objectives: Frischer and Larsson (2000) have identified the importance of "mutual agreement on goals and on tasks to reach the goals" (p.152) in forming an effective working alliance between supervisor and student; Lahenius and Martinsuo (2011) identified "good resources and goal-orientation as key factors that promote or delay the doctoral process" (p. 621); and Malfroy (2005) reported a "disparity in expectations" between students and supervisors, concluding that a degree of the identified uncertainty "stemmed from differing expectations about the professional doctorate degree" (p. 169). Previous work by Gardner (2007) has also identified the ad-hoc nature by which information is made available to doctoral students and highlighted the concern and frustration that can arise from such an approach.

Of equal interest is the misalignment between the perception (common to both students and supervisors) that publication is a key requirement (stipulated by the university) for submission of a doctoral thesis. At this juncture it is important to clarify that we are not against Ph.D. students publishing their work during the course of their studies *per se*. In contrast, the process of preparing a rigorous body of work for publication and debating methodological / conceptual queries raised in the course of peer review is, if framed appropriately, likely to constitute a highly engaging piece of formative assessment and source of motivation, as identified by a small number of students in the present study. We also acknowledge that having successfully published work during a Ph.D. is widely (and accurately) viewed as being beneficial to one's future scientific career.

From a constructive alignment perspective, the common perception (see responses by Students B, D, G, H, K and Supervisors D, E, F, G) that publication is a key doctoral requirement represents a significant misalignment with the planned assessment objectives. It is of additional interest that, although there was significant variation in the concordance between student and supervisor per-

ceptions of stated curriculum objectives, far greater alignment was observed between student and supervisor perceptions with regards the need to publish as part of a successful thesis.

Two potential explanations for this phenomenon may be drawn. The first relates to the generally interchangeable use of 'papers' and 'publications' to describe the publication of peer-reviewed manuscripts in the biomedical sciences. Although the synonymous use of the terms 'paper' and 'publication' may be a source of some confusion, our data suggests that supervisors, generally speaking, had an accurate appreciation of institutional guidelines for how theses are assessed. On this basis we consider it somewhat unlikely that a large proportion of supervisors in our cohort could simultaneously understand the stated curriculum assessment objectives whilst remaining confused regarding the use of 'paper' and 'publication'. Rather, we suggest this phenomenon may be explained by the increasing body of studies describing (and more often than not cautioning) the contemporary drive to maximise publication output in academic practice, especially in junior researchers (Bertamini & Munafò, 2012; Fronczak, Fronczak, & Hołyst, 2007).

Clear data exist to suggest that the increasing use of metrics (such as the *h* index, journal impact factors, and raw publication counts) to allocate limited research funding (the same funding commonly used to support both Ph.D. students' research and an increasing number of supervisors' salaries) has resulted in a marked increase in the per capita output of scientists over the past four decades (Fanelli, 2012a, 2012b; Fronczak et al., 2007). Congruent with this increase in output are emergent concerns regarding publication or dissemination bias (the selective reporting or publication of positive outcomes at the expense of negative or equivocal findings) on the basis that positive findings frequently generate more citations and are published in higher impact factor journals (Begg, 1985; Fanelli, 2010, 2012a, 2012b). We contend that our observation of an asymmetrical alignment in perceived curriculum assessment criteria that emphasises the importance of publication stems from the pressure placed upon Ph.D. supervisors to maximise publication output and the likely awareness of the importance of publications in securing future employment. Student D rated publications as "*the most important thing to me and therefore the biggest stressor to me over the thesis itself."* Student K stated that "*negative results will happen and I don't know if a thesis can be derived from that*." Student H reported that Ph.D. students in her laboratory focused on how many chapters (published papers) they had each done "*because no one really wants to do more than they need to*."

This shared perception constitutes a significant misalignment between the understood, created, and stated curriculum assessment objectives. A number of commentators have identified the progressive atrophying of research creativity and pioneering research, the atomisation of results and over-interpretation of marginal data in response to an overt focus on publications by established scientists (De Rond & Miller, 2005; Fanelli, 2012a; Lortie, 1999; Miller, Taylor, & Bedeian, 2011). We suggest that our observations regarding student and supervisor perceptions of curriculum assessment objectives raise significant concerns regarding the impact of an environment wherein the drive to publish has the potential to subordinate the technical, intellectual, and holistically transformative aspects of the doctoral learning experience.

# Conclusions

The present paper has employed constructive alignment to explore perceptions of curriculum assessment criteria reported in eighteen semi-structured interviews with Ph.D. students and supervisors drawn from the biomedical sciences at one Australian Go8 University. The limitations of this study (a relatively small sample size drawn solely from one Go8 University within the Australian higher education setting) mean that the data presented herein must be generalised with a degree of caution and, most certainly, further investigation in this area is warranted involving multiple institutions. With these caveats in mind, the key findings of this study are **i)** an apparent disconnect between student and supervisor perceptions of curriculum objectives, **ii)** a high degree of student

uncertainty regarding the actual requirements for successful completion of a doctorate in the biomedical sciences, and **iii)** a significant focus on the publication of positive data as a requirement for successful doctoral completion.

The practical implications of this work are two-fold. Earlier research by Gardner (2008, 2009a), Golde (2005), Barnes and Randall (2012), Lahenius (Lahenius & Määttä, 2011), and others have highlighted the importance of clear and commonly held understanding of goals and objectives to success in doctoral-level education. Accordingly, it seems reasonable that ensuring students are made aware of the importance of understanding the criteria against which they will be assessed and tailoring their activities accordingly may improve socialisation to the culture of their research environments and potentially improve learning outcomes. Indeed, the need for academic departments and supervisors to clearly explicate their expectations for students (both in terms of work practices and assessment requirements) was a key finding of the Carnegie Initiative on the Doctorate (Walker, Golde, Jones, Conklin-Bueschel, & Hutchings, 2008).

In the present study, many of the students who identified publication of their research as an examination requirement appeared to view this process as a form of summative assessment to be 'overcome'. This perspective is somewhat akin to adopting a surface approach to learning, characterised by a focus on the assessment itself, as opposed to the attainment of a meaningful understanding of the material to be assessed (Marton & Booth, 1997; Marton & Svensson, 1979). Interestingly, a small number of students adopted a diametrically opposed perspective, viewing the process of publication as a means by which they developed as scientists and improved the quality of their work. The institution represented in this study did not require the publication of research for completion of a biomedical doctorate when submitted as a series of papers; however, as discussed above, the link between publication, funding, and career progression in the biomedical sciences means that the pressure to publish, even as a student, is unlikely to dissipate. We suggest ensuring that the role of publication in the biomedical doctorate is better understood by both students and supervisors (important for one's career but not necessarily a requirement for a successful doctorate *per se*) is of paramount importance. Furthermore, if the publication process can be developed and framed as a useful formative exercise, it may assist in improving learning outcomes and future career prospects without engendering a superficial focus on publication as a form of assessment. Echoing commentary by other investigators, we also conclude that it is vital for academic departments to ensure that both students and staff are clearly informed of the stipulated assessment requirements for a doctoral thesis.

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