Determinants of PhD student satisfaction: the roles of supervisor, department, and peer qualities

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Abstract

Understanding the determinants of PhD student satisfaction is likely to become increasingly vital for universities as student satisfaction rankings already ubiquitous at undergraduate and master degree levels extend more broadly to the PhD level. Moreover, as PhD student populations and university competition become increasingly transnational, there is a growing need to understand cross-nationally common determinants of satisfaction. Building on prior research into PhD student satisfaction, and drawing upon relevant conceptual and metrical refinements in the measurement of satisfaction from cognate domains of psychology, we use cross-sectional data (N=409) from PhD candidates across the sciences, social sciences, and humanities in 63 universities from 20 countries to examine how overall PhD student satisfaction is determined by, respectively and in combination, supervisor, department, and peer-group, in terms of both their academic qualities and supportiveness. Taken together, we find that supervisor supportiveness is the greatest predictor of PhD student satisfaction, but that supervisor academic qualities have no significant effect. However, both the academic qualities and supportiveness of departments significantly predict PhD student satisfaction, suggesting university departments and PhD supervisors would ideally work jointly, and perhaps more closely than many currently do, to achieve competitive levels of PhD student satisfaction.

Key words: PhD-doctoral student satisfaction; supervisor; department; peers; academic qualities; supportiveness.

Introduction

With modern economies demanding ever higher levels of education, and with students themselves increasingly paying for their studies, students, universities and governments are becoming ever more concerned with the quality of education at undergraduate, master and PhD

levels. One consequence of this, on the assumption it is related to educational quality, has been an increasing interest in student satisfaction. National governments now assess student satisfaction at both undergraduate and master degree levels, and there is little reason to doubt that formal government-sponsored assessment of PhD student satisfaction will likewise be integrated into university ranking and funding systems.

Existing undergraduate and master degree student satisfaction data are not just used by governments and funders in their efforts to assess and drive up the quality of education through rankings and league tables (Barnes and Randall 2012). Satisfaction scores are also known determinants of students' university selection (Gibbons, Neumayer, and Perkins 2015), motivation (Donohue and Wong 1997), retention (Roberts and Styron 2010), completion rates (Neumann and Rodwell 2009), performance (Pike 1993), willingness to recommend their institution to others (Allen and Davis 1991), and intention to provide financial support as alumni (Sung and Yang 2009).

While PhD student satisfaction data may not yet ubiquitously be collected by governments, PhD student satisfaction, whether assessed or not, would seem arguably to contribute to higher PhD student wellbeing and, possibly, performance. PhD student satisfaction might also contribute to the decision by new PhDs to pursue academic careers, thereby enhancing their alma maters' research networks and the higher education profession more broadly. Several extant studies on PhD student satisfaction suggest the issue is already considered important by education scholars. Typical examples of studies shedding light on PhD student satisfaction include those focusing on aspects of the role of the supervisor (Ives and Rowley 2005; Zhao, Golde, and McCormick 2007; Erichsen, Bolliger, and Halupa 2014), those investigating the role of departments (Morton and Thornley 2001; Umbach and Porter 2002; Golde 2005), and those examining the role of student peer and social networks (Deem and Brehony 2000; Pilbeam, Lloyd-Jones, and Denyer 2013).

However, extant studies often focus mainly on just one or other possible determinant of PhD student satisfaction, and to date no study has sought to examine the extent to which the roles of supervisors, departments and peers in combination determine PhD student satisfaction. We attempt to build on current literature by examining how PhD student satisfaction across an international and discipline-diverse sample is predicted by supervisors, departments and peer-groups, both individually and in combination, providing insights into their relative importance and their unique contributions to student satisfaction. Moreover, we seek to add nuance to these insights by drawing on prior non-PhD student satisfaction research suggesting student satisfaction stems from two discrete aspects of learning: on one hand, educators' scholarly expertise, what might be labelled 'academic qualities', and on the other, non-academic aspects of the learning context and environment that might succinctly be labelled 'supportiveness' (Hendry 1983; Pascarella and Terenzini 2005; Kuh et al. 2006). We take these two identified contributors to student satisfaction and apply them separately in relation to supervisors, to departments, and to peers. Hence we also examine discretely the roles of, respectively, the academic qualities and the supportiveness of, individually and in combination, supervisors, departments and student peers.

Supervisors, departments and peer-group as determinants of student satisfaction

A wide range of determinants of student satisfaction have been considered in prior research such as discipline of study (Barnes and Randall 2012), university reputation (LeBlanc and Nguyen 1997), class size (Deanne, Teegan, and Mertova 2018), quality of facilities (Han et al. 2018), and student attributes (Wiers-Jenssen, Stensaker, and Grogaard 2002). However for PhD student satisfaction, supervisors, departments and student peer-groups appear to predominate as potential determinants.

It has sometimes been said that supervisors can 'make or break' a PhD student (Lee 2008, 267). Much research has been focussed specifically on the role of supervisors in PhD students' experience (Bastalich 2017), with previous research demonstrating a significant influence of supervisors on not just completion outcomes (Jacks et al. 1983; Golde 2005; Ives and Rowley 2005; Martinsuo and Turkulainen 2011) but also specifically on PhD student satisfaction (Zhao, Golde, and McCormick 2007; Bedggood and Donovan 2012; Erichsen, Bolliger, and Halupa 2014).

Academic departments have also been shown in prior research broadly to have an effect on student satisfaction (Volkwein and Carbone 1994; Berger and Braxton 1998; Umbach and Porter 2002), with various departmental characteristics found to influence student adjustment, progression, success, and satisfaction (Pascarella and Terenzini 1977, 1991, 2005; Hockey 1994; Borden 1995; Kuh 2003; Golde 2005; Baker and Pifer 2015).

Scholars have also investigated the role of fellow students in various aspects of the PhD student experience (Boud and Lee 2005; Pilbeam and Denyer 2009; Fenge 2012; Pilbeam, Lloyd-Jones, and Denyer 2013), including academic development and research progress (Baldwin, Bedell, and Johnson 1997; Shacham and Od-Cohen 2009; Walsh 2010; Martinsuo and Turkulainen 2011). However, as yet, only at the undergraduate and master levels has research explicitly investigated the relationship between peer-groups and satisfaction (Harnash-Glezer and Meyer 1991; Volkwein and Carbone 1994; Wiers-Jenssen, Stensaker, and Grogaard 2002; Arambewela and Hall 2013).

Academic qualities and supportiveness

Reviews of student learning (Pascarella and Terenzini 2005; Kuh et al. 2006) highlight the role of students' appraisals of both the academic qualities and the supportiveness of their learning environments as predictors of their satisfaction.

Academic qualities. Student satisfaction has been found to be heavily dependent on perceptions of their instructor's expertise and scholarly ability (Hendry 1983; Donald, Saroyan, and Denison 1995; Ives and Rowley 2005; Bedggood and Donovan 2012). However, wider departmental academic qualities and research emphasis have also been found to influence student satisfaction (Astin 1993; Volkwein and Carbone 1994; Umbach and Porter 2002), as has the academic-mindedness and scholarly ambition of fellow students (Spady 1970; Fenge 2012; Pilbeam, Lloyd-Jones, and Denyer 2013).

Supportive learning environment. Several studies have recognised the importance of broader supportiveness of the learning environment to student satisfaction. In relation specifically to supervisors, research has shown that a personally supportive nature is a major determinant of satisfaction and progress (Kam 1997; Zhao, Golde, and McCormick 2007; Martinsuo and Turkulainen 2011; Platow 2012; Erichsen, Bolliger, and Halupa 2014). Other research has highlighted the important supportive role of the wider department and university to satisfaction. For example, Umbach and Porter (2002) demonstrate that greater contact with departmental staff is associated with higher student satisfaction, with better integration into faculty and departmental communities associated with lower PhD-study abandonment (Girves and Wemmerus 1988; Hockey 1994; Golde 2005). Supportiveness of immediate student peer-groups has also been found to contribute to student satisfaction, with good peer relations, positive peer climates, and extended peer networks contributing to satisfaction (Harnash-Glezer and Meyer 1991; Baldwin, Bedell, and Johnson 1997; Wiers-Jenssen, Stensaker, and Grogaard 2002).

Propositions

Existing research cited above gives adequate suggestion that, separately, supervisors, departments and peer-groups each have an effect on PhD student satisfaction. Existing research

also suggests that, respectively, academic qualities and supportiveness both have an effect on PhD student satisfaction. Hence we might reasonably set out the following propositions:

P1a. Supervisors' academic qualities will predict PhD student satisfaction.

P1b. Supervisors' supportiveness will predict PhD student satisfaction.

P2a. Department academic qualities will predict PhD student satisfaction.

P2b. Department supportiveness will predict PhD student satisfaction.

P3a. Peer-groups' academic qualities will predict PhD student satisfaction.

P3b. Peer-groups' supportiveness will predict PhD student satisfaction.

However, the absence of PhD student satisfaction research simultaneously examining, on one hand, the roles of supervisors, departments and peer-groups and, on the other, the separate roles of the academic qualities and supportiveness, necessarily leads us to more speculative propositions when considering which might be the largest predictors of student satisfaction.

With respect to the relative importance of supervisors, departments and peer-groups, combining both their academic qualities and supportiveness together in each case, we speculate that supervisors will be the largest predictor of PhD student satisfaction. The supervisor's role in the PhD student's experience would ostensibly seem paramount, and previous research comparing the relative importance of multiple determinants of student satisfaction generally support this view (Harnash-Glezer and Meyer 1991; Astin 1993; Krehbiel, McClure, and Pratsini 1997; Remedios and Lieberman 2008; de Kleijn et al. 2012). Hence we propose:

P4a. Supervisors' academic qualities and supportiveness combined will be a larger predictor of PhD student satisfaction than the academic qualities and supportiveness combined of either departments or peer-group.

Turning to the relative importance of departments versus peer-group in predicting PhD satisfaction, extant literature offers inconclusive results. The work of several scholars suggests

that departmental factors should be more important than peers to PhD satisfaction (Liegler 1997; Clemes, Gan, and Kao 2007; Gruber et al. 2010). However, the work of other scholars suggests the opposite (Harnash-Glezer and Meyer 1991; Astin 1993; Wiers-Jenssen, Stensaker, and Grogaard 2002). Contradictory findings here are possibly the result of non-comparable operationalisations of department and peer characteristics. Nevertheless, research by Volkwein and Carbone (1994) and Umbach and Porter (2002) indicates that departmental factors clearly have an instrumental effect on satisfaction, whereas in a meta-analysis of student satisfaction studies Gibson (2010) found the role of peers to be only secondary. Hence, in the context of PhD student satisfaction, it would seem reasonable to propose that:

P4b. Department academic qualities and supportiveness combined will be a larger predictor of PhD student satisfaction than the academic qualities and supportiveness combined of PhD peer-group.

Contrasting the general importance of academic qualities and supportiveness, Kuh et al. (2006) maintain that some aspects of educational supportiveness may better promote students' commitment and persistence in graduating. This assertion is further supported by Salmon (1992), Gardner (2007), Bedggood and Donovan (2012), and de Kleijn et al. (2012) whose work suggests that an agreeable supervisory relationship and personal support are more important for student satisfaction than supervisor academic ability and knowledge. Moreover with respect to the university experience as a whole, Elliot and Healy (2001) and Overall, Deane, and Peterson (2011) likewise determined that the perception by students that they were welcome and valued was the strongest determinant of their satisfaction, surpassing instructional effectiveness. These conclusions lead us to the following proposition:

P5. Supportiveness will be a larger predictor than academic qualities of PhD student satisfaction.

Methods

Sample and procedure

We sought a heterogeneous sample to obtain results reasonably robust to generalisation. Student satisfaction scholars have underlined potential restrictions to generalisability stemming from single discipline samples (Liegler 1997; Mai 2005; Appleton-Knapp and Krentler 2006). Accordingly, we obtained data from PhD students across sciences, social sciences, and humanities. Other student satisfaction researchers highlight potential limitations of using single-university samples (Harnash-Glezer and Meyer 1991; Husbands 1996; Umbach and Porter 2002; Egan et al. 2009; de Kleijn et al. 2012; Berbegal-Mirabent, Mas-Machuca, and Marimon 2016; Pedro and Franco 2016; Maxwell-Stuart et al. 2018), hence we sought data from PhD students in multiple universities, 63 in total. Still other researchers have noted possible problems of generalisability using single-country samples (Wiers-Jenssen, Stensaker, and Grogaard 2002; Neumann and Rodwell 2009; Arena, Arnaboldi, and Azzone 2010; Arambewela and Hall 2013; Ali et al. 2016). So we endeavoured to obtain an international sample, ultimately getting responses from 20 countries across North America, Europe, and the Asia-Pacific, with some 54% from Anglophone countries.

We pilot-tested an online instrument using our own PhD students as the sample. A finalised instrument was then administered by asking professional academic colleagues across disciplines and around the world to forward an invitation email with embedded instrument link to their current PhD students. We stressed that we wanted to sample candidates doing research-based PhDs and not those doing taught or professional doctorates with scant, if any, substantive original theorisation, research or analysis component. Ours is hence a convenience sample. Instruments were completed anonymously. A total sample of 409 fully completed responses was thus achieved, descriptive statistics for which are given in Table 1.

= INSERT TABLE 1. =

Measures

Dependent variable

Though definitions and measures of student satisfaction have varied considerably, student satisfaction is explicitly or implicitly conceptualised as an overall positive attitudinal response to an educational experience (Athiyaman 1997; Elliott and Healy 2001; Helgesen and Nesset 2007). As such, student satisfaction is inherently a unitary affective construct capturing an overall feeling towards an overall educational experience. Hence, student satisfaction is most appropriately and directly measured with items tapping how students subjectively feel about their educational experience as a whole.

Some research overtly conceives and consonantly measures student satisfaction directly as an overall affective construct (e.g. Clemes, Gan, and Kao 2007). Other research conceptualises student satisfaction as an overall affective construct but seeks to measure it indirectly through cognitive appraisal of particular facets of an educational experience or environment. Such cognitive measurements assume that overall affective student satisfaction can be measured vicariously through summation of satisfaction or performance scores relating to varying numbers of varying facets of an educational experience or environment. For example, Elliott and Shin (2002) conceptualise student satisfaction as an overall 'affective student outcome' (198), but opt for a cognitive measurement approach comprising assessments of specific conditions such as having a 'safe and secure campus' and being 'able to get desired classes' (202). Arambewela and Hall (2013) again would seem to conceptualise student satisfaction affectively as 'satisfaction with [the] overall educational experience', but choose to operationalise their measurement with a 'composite construct, which is a summated measure of satisfaction with key aspects of the internal and external university environments' (973). Similarly, Barnes and Randall (2012) conceive PhD student satisfaction affectively as 'levels of overall satisfaction' (56) but decide to use a cognitive measurement approach

comprising a summated scale including items like 'I am satisfied with the amount of time I spend with my advisor' and 'I am learning good research practices' (72).

Cognitive conceptualisations and measurements of student satisfaction can, of course, be useful in the specific research settings for which they are explicitly used. However, to assume that affective student satisfaction is measurable by a summation of cognitively assessed satisfaction with any given set of facets of an educational experience can be problematic. Not only are different studies' results incomparable due to variability in cognitive measures' selected facets, but it has long been demonstrated in the allied domains of organisational and consumer psychology that affectively and cognitively conceived and operationalised satisfaction with jobs and consumption, respectively, are both differently predicted and have different outcomes (Organ and Near 1985; Brief and Roberson 1989; Moorman 1993; Homburg, Koschate, and Bayless 2006; Kaplan et al. 2009; Thompson and Phua 2012). Hence, conceptualising student satisfaction affectively but then measuring it cognitively may result in misleading findings: not only is it unlikely that any particular selected set of specific facets of an educational experience will fully explain variance in affective student satisfaction, it also erroneously conflates cause with effect. While satisfaction with selected cognitive facets of an educational experience may each partially contribute towards affective student satisfaction, as Cheng and Marsh (2010, 697) stress, they will not in and of themselves encompass affective student satisfaction.

We explicitly conceptualise overall PhD student satisfaction as an affective construct. We seek to assess the influence on PhD student satisfaction of the supportiveness and academic qualities of, respectively, supervisors, departments and PhD peers: we do not assume that these in and of themselves either constitute PhD student satisfaction or account for all but a portion of variance in PhD student satisfaction. Hence, we sought to measure overall PhD student satisfaction affectively, directly, reliably, and validly.

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Despite their respective merits, we found extant measures of overall affective student satisfaction suboptimal for our purposes because they variously; have constrained internal consistency reliability resulting from too few, often single, items (e.g. Banwet and Datta 2003; Mai 2005; Appleton-Knapp and Krentler 2006; Douglas et al. 2006; Arena, Arnaboldi, and Azzone 2010; Lenton 2015), or they conflate satisfaction with related but nevertheless distinct constructs (e.g. Bean and Bradley 1986; Palacio, Meneses, and Perez 2002; Schlesinger, Cervera, and Perez-Cabanero 2016), or they incorporate manifestly cognitive items (e.g. Thomas and Galambos 2004; Brown and Mazzarol 2009), or they have somewhat ambiguous or difficult wording (e.g. Ali et al. 2016; James and Casidy 2018). Such features of extant student satisfaction measures may have unfortunate consequences. For example, one nationwide government-sponsored survey which did not employ a multi-item satisfaction scale found that PhD students' assessments of satisfaction 'were almost completely devoid of reliability', and that the lack of correlation with external validity criteria such as research productivity, award receipt, and attrition rates 'calls into question the construct validity of the responses' (Marsh, Rowe, and Martin 2002, 339).

Hence, to ensure a direct, purely affective, unidimensional, valid, reliable, and both time- and space-efficient measure, we devised a 10-item lexical measure. We asked: *Thinking about your overall experience of your PhD as a whole, how much do you agree that the following words accurately describe your overall PhD experience to date?* A 6-point interval measure running from Strongly Disagree to Strongly Agree was then used to indicate the extent of agreement to the subsequent single-word affective items: *Good, Unhappy, Enjoyable, Satisfactory, Bad, Terrible, Excellent, Disappointing, Happy, Unsatisfactory*. The mixed valance of these items was designed to reduce response set and acquiescence responding (Knowles and Nathan 1997). An exploratory principal component analysis found the scale to

be unidimensional, with a single component accounting for 67% of variance, and no factor loading below .73. Cronbach's alpha of internal consistency reliability is .94.

Independent variables

We assessed PhD candidates' actual experience of, respectively, the supportiveness and academic qualities of, discretely, supervisors, departments and peers. As we could locate neither explicit nor consistent implicit definitions, or suitable measures, of either construct in extant research, we devised bespoke and maximally space- and time-efficient measures applicable broadly and plausibly to, respectively, supervisors, departments, and peer-groups.

Procedurally, we sought to derive clear and concise definitions of the constructs of supportiveness and academic qualities from a PhD candidate perspective through means of a focus group discussion with 13 PhD candidates at one author's university. These were pursuing PhDs across a range of subjects and came from 11 countries (Britain, China, Germany, Greece, India, Ireland, Romania, Saudi Arabia, South Korea, Turkey and the United States). We initiated discussion by framing the notions of supportiveness and academic qualities in the context of extant research on both, and were thereby able to use a deliberately broad, vague, non-leading and tentative idea of each construct as a basis on which to proceed.

The notion of supportiveness was found to be a cognitive perception of receiving not so much practical or systematised support, but an overall sense of having a constructively concerned, thoughtful, understanding and reassuring environment. This was regarded as applying similarly to supervisors, peers, and departments. Employing this conceptualisation, and the words used by focus-group participants themselves, we put together a parsimonious 5-item lexical scale with face validity that covered the domain of supportiveness without redundancy. We used the question stem: 'From your personal experience, how much do you

agree that your (supervisor(s)/department or school/peer-group, as appropriate) is(are);' then the item words *Caring*, *Considerate*, *Encouraging*, *Supportive*, and *Sympathetic*.

The notion of academic qualities prove to be regarded straightforwardly as a cognitive perception of being, in the succinct words of one participant, 'scholastically highbrow'. In discussing the construct in relation to both supervisors and peer-groups, participants used words like clever, intelligent, smart, knowledgeable, educated, intellectual, academic, cerebral, learned, and scholarly. In discussing the same construct in relation to departments, participants did use a few similar terms, such as intellectual, but mainly used terms like scholarly standing, research reputation, and academic quality, reflecting a department's non-person and more institutional nature. Accordingly, we deemed constructing a single, parsimonious, and non-redundant scale applicable alike to supervisors and peer-groups and also to departments would be inappropriate: the wording would necessarily be awkward and likely fail directly to tap accurately the common underlying construct of academic quality in relation to both people (supervisors and peer-groups) and an institution (departments). Hence, we constructed a 4-item lexical measure for application commonly to both supervisors and peer-groups, using the same question stem as for supportiveness, and comprising the words *Intelligent*, *Knowledgeable*, *Intellectual*, and *Scholarly*. For departments we substituted those items with *Famous in its field*, *Hard to get into*, *Prominent for its research*, and *Renowned for its quality*. The internal consistency reliability of Supportiveness for supervisor(s) was α .83, for department α .87, and for peers α .89; and for Academic Qualities internal consistency reliability for supervisor(s) was α .83, for department α .82, and for peers α .91.

Control variables

Because ours is an international, cross-disciplinary and convenience sample, we sought to control germane variables to derive more generalisable findings.

Age and sex. Student satisfaction has been linked to age (Muijs and Bohove 2017) and sex (Umbach and Porter 2002), hence we controlled for these.

National PhD procedural heterogeneity. While the nature of PhD research has many commonalities across countries, national differences in supervisory arrangements, taught training, and other areas exist that might affect PhD satisfaction. Accordingly, we controlled for country of PhD institution, creating dummy variables for each country from which over 5% of total responses were derived, resulting in dummies for British, American, Australian, and (non-British) European universities.

University quality. As we are interested in the effect of department characteristics on PhD satisfaction rather than the university in which this might be set, we sought to control for university quality. We did this primarily in terms of research by using publicly available university rankings as a preliminary guide, albeit doing so fully cognisant of the different and sometimes specious criteria used by such rankings (Times Higher Education 2016; TopUniversities 2016; U.S. News Education 2016). To create clear and maximally discrete categories, we defined one dummy to include institutions that might arguably find consensus as being among leading research universities both nationally and internationally. This included such institutions as Australian National University, Cambridge, Harvard, Imperial College, London School of Economics, Oxford, Stanford, and others, and were represented by 98 students in our sample. At the opposite end of the spectrum we created a category of universities that did not appear in any international ranking, or are generally known to be predominantly teaching oriented. Some 57 respondents were studying at universities in this category. The remaining mid-ranking universities comprised 254 respondents and were used as the reference category variable.

Years and mode of study. From professional experience supervising PhDs and managing PhD programs we have noted an apparent decline in PhD candidate satisfaction

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related to how many years they have been on their program, hence we controlled for years of study. As a corollary, we also control for full or part-time mode of study.

Field of study. As the nature of PhD study varies considerably across disciplines (Pole 1998; Egan et al. 2009), we controlled for field of study, aggregating these into social sciences and sciences, with other disciplines in arts and humanities used as a reference category variable.

Results and discussion

To check for possible multicollinearity problems stemming from method variance, we ran regression diagnostics. The mean Variance Inflation Factor (VIF) across all variables was 1.96, with no VIF over 4.84, well below the rule-of-thumb suggested by Hair et al. (1995) of 10.00 as indicative of potential multicollinearity problems, and below the more stringently conservative 5.00 suggested by Ringle, Wende, and Becker (2015).

Table 2 shows regressions entering supervisor, department, and peer-group variables separately. Model 1 serves as a baseline entering only control variables. Models 2, 3, 5, 6, 8 and 9 show that, respectively, supervisor, department and peer academic qualities and supportiveness separately each predict PhD student satisfaction, and each significantly increases explained variance in PhD satisfaction over the baseline Model 1 of controls alone. Thus our propositions P1a through P3b are supported.

= INSERT TABLE 2. =

Models 4, 7 and 10 each combine both the academic qualities and supportiveness of, respectively, supervisor, department, and peers. The respective explained variances in PhD student satisfaction support the hierarchy of relative importance predicted in propositions P4a and P4b, with supervisor being the largest predictor of PhD student satisfaction followed by department then peers. Models 4, 7 and 10 also reveal that for both supervisor and department,

supportiveness is a larger predictor of PhD student satisfaction than academic qualities, but that for peers academic qualities is significant whereas supportiveness is not.

Table 3 shows regressions entering supervisor, department, and peer variables in combination. To examine whether academic qualities overall or supportiveness overall explains more variance in PhD student satisfaction, Model 1 enters only academic qualities for supervisor, department, and peers combined, while Model 2 enters only supportiveness for supervisor, department, and peers combined. The significantly higher (p<.01) variance in PhD student satisfaction explained by supportiveness overall tends to support our proposition (P5), that supportiveness overall is more important than academic qualities overall to PhD student satisfaction.

= INSERT TABLE 3. =

Finally, Model 3 enters simultaneously for supervisor, department and peers both academic qualities and supportiveness, thereby controlling for any covariance across variables and hence revealing the unique effect of each. In this full model, only supervisor supportiveness and the academic qualities and supportiveness of the department retain significant effects on PhD student satisfaction. Of these, supervisor supportiveness has the largest beta, followed by department supportiveness, then department academic qualities.

In sum, therefore, we find that; (i) supervisors are the largest contributors to PhD student satisfaction, but this is driven solely through their supportiveness and not academic qualities, (ii) likewise supportiveness overall is more important than academic qualities overall, (iii) that departments really matter in regards both to supportiveness and academic qualities, and (iv) peers overall have no independent effects on PhD student satisfaction.

These findings do not categorically contradict prior research suggesting the academic qualities of supervisors are important to PhD student satisfaction (e.g. Donald, Saroyan, and

Denison 1995; Zhao, Golde, and McCormick 2007; Bedggood and Donovan 2012). However, they do suggest that in the context of wider department academic qualities combined with supportiveness from both supervisor and department, the academic qualities of supervisors are less salient. This result would seem consonant with recent trends towards PhD programmes that both increasingly incorporate supervisory teams rather than single supervisors, and provide more formal research training that is often department- rather than supervisor led.

Our findings also seem to suggest that when PhD students' supervisory and departmental support needs are met, their satisfaction with their PhD is not affected by either peer academic qualities or peer supportiveness. While this contrasts somewhat with research at the undergraduate and master levels (e.g. Harnash-Glezer and Meyer 1991; Volkwein and Carbone 1994; Baldwin, Bedell, and Johnson 1997; Wiers-Jenssen, Stensaker, and Grogaard 2002), we suspect our finding here may reflect two things. First, the less taught-class and more 'individual nature' (Slight 2017, 43) of PhD study that, relatively speaking, limits structured contact between PhD student peers, and second, the vastly greater salience of supervisors and other experienced scholars in guiding and supporting a successful PhD. Nonetheless, to unpick whether this apparent insignificance of peers is in fact universally applicable to all PhD study or merely an artefact of particular institutional circumstance, future research could investigate the extent to which extensively 'taught' or cohort PhDs, whose programs more actively incorporate shared training and development activities, also exhibit the same characteristics.

The significance of multiform sources of both expertise and support to PhD student outcomes has been noted for some time (e.g. Rudd 1975; Welsh 1979; Winfield 1987; Elton and Pope 1989), and continues to attract considerable research attention. Recent studies by, for example, Pearson, Evans, and Macauley (2016) and Spronken-Smith, Cameron, and Quigg (2018) highlight the value of PhD student access to diverse resources and networks, while Baker and Pifer (2015) and Bastalich (2017) stress the importance of PhD candidate

assimilation into the relevant academic community, and Posselt (2018) underscores the wide-ranging 'holistic' faculty support necessary for effective PhD progression. Given the relatively advanced and technical skills required to succeed in research environments, it is perhaps not surprising that the cultivation of such 'communities of practice' (Tight 2015, 115) appears especially germane to the context of PhD study. Yet with regard to student satisfaction specifically, to the authors' knowledge, this is the first study to have categorised, identified, and quantified aspects of this importance at the PhD level. Future research seeking to yield further insights into the nature of these effects might therefore usefully contrast the relative importance of these same determinants of student satisfaction across other levels and domains of higher education whose inherent characteristics differ.

Conclusions

Our study makes an original and timely contribution to the understanding of PhD student satisfaction by adding some clarity and structure to the separate and combined effects of supervisor, department and peers, in terms both of academic qualities and of supportiveness. We find that each of these three facets of the PhD experience separately are found to be significant, while supervisors have the greatest impact on satisfaction, followed by department, then peers, and supportiveness across these three groups is more influential than academic qualities. Furthermore, when all factors are assessed concurrently, only the influences of supervisor supportiveness along with both department academic qualities and supportiveness appear to predict PhD student satisfaction, and by corollary that supervisor academic qualities and peers overall are insignificant.

Before drawing out potential implications of these findings, the limitations of our research must be kept in mind. The size and composition of our sample are in line with, and in certain respects improve on, some prior research, and are adequate for our general purpose. However, we obtained insufficient data to allow highly nuanced analyses by, for example,

country of PhD institution, discipline, or nationality of student. Clearly, given the heterogeneous nature of PhD programmes by discipline and other dimensions such as country, far larger samples, if feasibly collectable, would be advantageous in shedding additional light on the determinants of PhD student satisfaction. Ours is also a convenience sample, and we were obliged to use several pertinent controls to help attenuate possible biases sometimes attendant with such samples. Notwithstanding our efforts at mitigation here, our findings are subject to the standard criticisms of non-probability sampling bias, namely possible non-representativeness and constrained generalisability. Furthermore, like all analyses based on survey data, ours are potentially susceptible to method variance. While we deliberately ensured the design of our instrument and scales took this into account, by for example using positively and negatively valanced items, method variance may potentially influence the absolute effect sizes of our analyses. However, that said, method variance would not influence the relative magnitude of effect sizes we found, meaning the hierarchy of effects we report is likely robust. We also note the caveat that the different wording it was necessary to use in measuring academic qualities in relation to departments, on one hand, and to supervisors and peers on the other, may in some degree affect their absolute direct scalar equivalence, if not necessarily their relative qualitative meaning or hierarchy.

Limitations notwithstanding, our results suggest that to increase PhD student satisfaction universities might usefully focus on improving the academic expertise of their departments as a whole while ensuring that supportiveness both at department and, especially, supervisory levels are of a high standard. At the same time, this implies that PhD supervisors and their departments should perhaps seek to work jointly, and perhaps more closely than many currently do. Additional strategic implications extend to human resource management where attracting single 'star' academics, for instance, would seem to be less advantageous than equivalent efforts at cultivating more broadly collegial but capable faculties.

Of course, simply asking supervisors or departments to be more cooperatively supportive of PhD students is unlikely to be effective unless precisely what constitutes supportiveness is known in worthwhile detail. We have deliberately used a broad construct of supportiveness to tap a general sentiment rather than any specific practical actions. No doubt supportiveness does comprise in part being caring and sympathetic, for example, but efforts to build on our results might begin by attempting to find out exactly what PhD students do and do not regard as meaningfully useful and practically implementable supportiveness. Hence, for our own study now to be translated into actions that universities can use to enhance the competitiveness of their levels of PhD student satisfaction, we would urge that a future research agenda in the area include unpacking direct from a PhD student perspective the practical constituents of supervisor and departmental supportiveness: they will likely have elements that are the same, but may well have elements that differ.

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Table 1. Descriptive statistics: means, standard deviations and correlations with PhD students' satisfaction

	Mean/(%)	SD	Correlations with PhD satisfaction
PhD Satisfaction	4.55	1.04	-
Controls			
Age	31.84	8.24	-.04
Sex	(37)	-	.03
British	(36)	-	.02
American	(09)	-	-.09
Australian	(06)	-	.11 *
European	(22)	-	.04
Leading research university	(24)	-	-.17 **
Teaching oriented university	(14)	-	-.05
Year of study	2.53	1.41	-.29 **
Full-time	(88)	-	.00
Social sciences	(52)	-	-.06
Sciences	(33)	-	.05
Experience of factors:			
Supervisor: academic qualities	5.35	0.61	.45 **
Supervisor: supportiveness	5.25	0.64	.58 **
Department: academic qualities	4.38	0.92	.30 **
Department: supportiveness	4.75	0.80	.50 **
Peer: academic qualities	4.83	0.87	.31 **
Peer: supportiveness	4.88	0.89	.28 **

Notes. * p < .05, ** p < .01. Sex dummy coded male 1.

Table 2. Regressions showing separate and joint effects of academic qualities and supportiveness of, respectively, supervisors, departments and peers on PhD students' satisfaction.

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8		Model 9		Model 10	
	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β
Controls																				
Age	.01	-.04	.01	-.05	.01	-.01	.01	-.02	.01	-.06	.01	-.04	.01	-.05	.01	-.05	.01	-.04	.01	-.05
Gender	.10	.04	.09	.03	.08	.03	.08	.03	.09	.05	.09	.04	.09	.04	.10	.07	.10	.07	.10	.07
British	.13	.02	.12	.02	.11	.05	.11	.05	.12	.04	.12	.07	.11	.07	.13	-.02	.13	-.02	.13	-.03
American	.20	-.02	.18	-.02	.16	-.02	.16	-.02	.18	.03	.17	.00	.17	.02	.19	-.02	.19	-.03	.19	-.02
Australian	.25	.12 *	.22	.12 *	.20	.13 **	.20	.13 **	.23	.21 **	.22	.16 **	.22	.20 **	.24	.09	.24	.09	.24	.09
European	.15	.10	.13	.10	.12	.10 *	.12	.10 *	.14	.12 *	.13	.11 *	.13	.13 *	.14	.09	.14	.09	.14	.09
Leading research university	.13	-.14 **	.12	-.11 *	.11	-.07	.11	-.07	.13	-.26 **	.12	-.09	.12	-.17 **	.13	-.19 **	.13	-.16 **	.13	-.19 **
Teaching oriented university	.15	-.03	.14	.00	.13	.00	.13	.00	.15	.06	.14	-.01	.14	.04	.15	-.02	.15	-.03	.15	-.02
Years of study	.04	-.26 **	.03	-.22 **	.03	-.18 **	.03	-.18 **	.03	-.23 **	.03	-.18 **	.03	-.18 **	.03	-.23 **	.04	-.24 **	.03	-.23 **
Full-time	.17	-.03	.15	-.01	.14	.01	.13	.01	.15	-.01	.15	.00	.14	.00	.16	-.02	.16	-.01	.16	-.02
Social sciences	.14	-.04	.13	-.07	.12	-.05	.12	-.06	.13	-.06	.13	-.01	.12	-.03	.14	-.03	.14	-.03	.14	-.03
Sciences	.16	-.03	.15	-.05	.13	.05	.13	.03	.15	-.07	.14	-.05	.14	-.08	.16	-.04	.16	-.03	.16	-.04
Main effects																				
Supervisor: academic qualities	-		.05	.42 **	-		.06	.15 **	-		-		-		-		-		-	
supportiveness	-		-		.04	.56 **	.05	.47 **	-		-		-		-		-		-	
Department: academic qualities	-		-		-		-		.05	.41 **	-		.05	.24 **	-		-		-	
supportiveness	-		-		-		-		-		.04	.46 **	.04	.37 **	-		-		-	
Peer: academic qualities	-		-		-		-		-		-		-		.05	.31 **	-		.10	.30 **
supportiveness	-		-		-		-		-		-		-		-		.04	.27 **	.08	.01
R^2	.124		.297		.398		.432		.261		.301		.341		.217		.168		.217	
F Statistic	4.67**		12.85**		21.79**		21.41**		10.72**		14.54**		16.04**		8.40**		7.36**		7.78**	
ΔR^2			.173**		.294**		.308**		.137**		.201**		.239**		.093**		.071**		.093**	

Notes. * $p < .05$, ** $p < .01$. Betas standardised.

Table 3. Regressions showing effects on PhD students' satisfaction of academic qualities, supportiveness, and both combined across supervisor, department and peers

	Model 1		Model 2		Model 3	
	SE	β	SE	β	SE	β
Controls						
Age	.01	-.06	.01	-.02	.01	-.03
Sex	.09	.05	.08	.04	.08	.04
British	.11	.01	.11	.05	.10	.06
American	.17	.01	.15	-.02	.15	.01
Australian	.22	.16 **	.20	.13 *	.20	.17 **
European	.13	.11 *	.11	.11 *	.11	.12 **
Leading research university	.12	-.20 **	.10	-.07	.11	-.13 **
Teaching oriented university	.14	.05	.12	.00	.12	.04
Years of study	.03	-.21 **	.03	-.15 **	.03	-.15 **
Full-time	.14	-.01	.13	.02	.13	.02
Social sciences	.12	-.07	.11	-.03	.11	-.05
Sciences	.14	-.07	.13	.02	.13	-.01
Main effects						
Supervisor:						
academic qualities	.06	.30 **	-		.06	.07
supportiveness	-		.04	.43 **	.05	.37 **
Department:						
academic qualities	.05	.24 **	-		.05	.16 **
supportiveness	-		.04	.22 **	.04	.17 **
Peer:						
academic qualities	.05	.12 *	-		.08	.07
supportiveness	-		.04	.09 *	.07	.01
R^2	.361		.471		.499	
F Statistic	14.79**		23.34**		21.62**	
ΔR^2	.237**		.347**		.375**	

Notes. * $p < .05$, ** $p < .01$. Betas standardised. ΔR^2 is from Model 1 Table 2.