Validation of the Quality in PhD Processes Questionnaire

Increasing interest in PhD processes calls for valid and reliable survey instruments that cover key aspects of the PhD experience. Based on recent research, existing questionnaires, and interviews with PhD students, the Quality in PhD Processes Questionnaire (QPPQ) was developed to cover a range of influential factors, such as perceptions of research environments and psychological well-being. This study assesses the validity of the QPPQ's scales with special attention to factorial, convergent, and discriminatory validity. Six scales were developed based on exploratory and confirmatory factor analyses applied to 23 items in a sample of 1,670 PhD students representing various academic disciplines. Results were promising concerning the scales' psychometric properties and indicators of validity. The QPPQ offers itself as a thoroughly tested instrument for the purposes of evaluating and developing PhD programmes at local levels and for researching PhD processes in general.

KEYWORDS: postgraduate research; PhD education; doctoral education; research environment; questionnaire;

Introduction

Postgraduate research has become pivotal to knowledge-based economies in general and research-intensive universities in particular. Due to the growing focus on postgraduate research education, interest in survey instruments that allow for benchmarking, academic development, and research has risen significantly within the past decade, and various questionnaires have been developed in Australia, North America, and the UK (Sampson *et al.*, 2016). One of the most widely used surveys, the Postgraduate Research Experience Questionnaire (PREQ), was developed in a project by the Australian Council for Educational Research in 1999 and is currently administered annually to approximately 40 different higher education institutions throughout Australia (Graduate Careers Australia, 2011). Another survey, the Postgraduate Research Experience Survey (PRES), was developed in the UK. It was first launched in 2007 and is conducted annually across 123 institutions (Turner, 2015). In Canada, the Canadian Graduate and Professional Student Survey (CGPSS) was developed based on a pilot survey in the USA. The CGPSS was introduced in 2007 and is employed by more than 40 Canadian universities (Canadian Association of Graduate Studies, 2013). In addition to these surveys, many universities have developed their own surveys to accommodate local preferences and foci; some examples include a version of the PREQ developed at Oxford University (OPREQ) (Trigwell and Dunbar-Goddet, 2005) and the biannual Research Student Satisfaction Survey (RSSS) (University of Western Australia, 2009).

The PhD student experience is the focus of all of the above-mentioned questionnaires, and themes such as infrastructure, supervision, overall satisfaction, assessment of skill development, and perceptions of research environments are common variables. However, on closer inspection, immense differences between surveys become apparent with regard to aim, scope, length, focus, methodology, and theoretical grounding. For example, local surveys, such as the CGPSS and the RSSS, focus primarily on PhD students' satisfaction with local infrastructure and formal training. Cross-university surveys, such as the PREQ and the PRES, are shorter, and their response items appear to be more evenly distributed between themes concerning infrastructure, supervision, skill

development, and perception of the research environment. It should be noted that, although some themes appear across different surveys, the quality and content of individual items within the same themes vary greatly; for example, the meaning of research environment differs considerably between individual surveys.

In continuation of these survey instruments, this article reports on the development and validation of the Quality in PhD Processes Questionnaire (QPPQ). The QPPQ was developed in the context of Danish postgraduate education; nonetheless, it adds to the existing international pool of survey instruments for a number of reasons. The QPPQ incorporates a large pool of items covering various aspects of PhD students' integration within everyday research environments. Predominant surveys, such as the PREQ and the PRES, focus on quality indicators that are primarily of interest at the institutional level. However, Juniper *et al.* (2012) argued that psychological aspects are just as important for individual PhD students; hence, the QPPQ covers psychological aspects that are important in terms of productivity (Lonka *et al.*, 2014) and progression (Mason 2012).

Development of the Quality in PhD Processes Questionnaire (QPPQ)

As indicated in the title of the questionnaire, the instrument was conceptually founded on two main dimensions: 1) Quality and 2) PhD processes. Based on a review of the research literature, the following parameters were selected as representing quality: satisfaction, well-being, ownership, research self-efficacy, publication, and study progress/completion. These themes were chosen because prior research has stressed the importance of studying PhD students' satisfaction (e.g. Mason 2012), well-being (e.g. Stubb *et al.,* 2011), independence (Gardner 2008), research self-efficacy (Overall *et al.,* 2011), publication output (Badley, 2009), and completion rates (e.g. Bair and Haworth 2005). In sum, these themes cover a continuum of socio-psychological process goals towards more production-related goals; thus, they measure a relevant span of success indicators. Based on the literature, a number of themes were identified to illustrate core elements in the PhD process, including entering PhD studies (Neumann, 2003), receiving formal training (Gilbert *et al.,* 2004), teaching courses (Trigwell and Dunbar-Goddet, 2005), attending supervision (Platow, 2012; Lovitts, 2001), and participating in the everyday research environment (Golde, 2005; Gardner, 2010).

The QPPQ was developed in 2013 with two major purposes. First, the instrument should support the formative assessment of PhD programs at the particular university where it was developed. Second, the instrument should allow for the construction of scales that would make research on PhD processes possible. To accommodate the double focus of the QPPQ, local expertise and international research literature were consulted. Most items are unique to the QPPQ and are based on theory and research on the PhD experience and interviews carried out with PhD students. Existing questionnaires were consulted as well, and in some cases, individual items were directly adopted from surveys by Trigwell and Dunbar-Goddet (2005), Golde and Dore (2001); Zhao *et al.* (2007), and Overall *et al.,* (2011). Drafts of the questionnaire have been subject to a thorough bottom-up process involving all relevant local stakeholders. It has been

presented and discussed in several meetings among heads of graduate schools, heads of PhD programmes, and a local PhD students' association. Finally, four focus-group interviews were held with a total of 16 PhD students from each of the university's four faculties. These interviews resulted in the revision of wording and vocabulary when necessary with regards to discipline-specific terminology. After going through the questionnaire, some PhD students noted that the item '*Do you feel lonely during your day at your workplace*?' could be augmented. They felt that the feeling of being alone with one's project was just as important as and qualitatively different from feelings of loneliness on a social level. Thus, the item '*Do you feel that you act alone in your project and lack the necessary feedback to make progress?*' was included to address the type of academic loneliness PhD students' reported in interviews. Items reported on in this study (see appendix) were scored by means of a 5-point Likert scale.

Aim of study, validity, and research questions

The aim of the present study is to assess the validity of the QPPQ. Because an exhaustive description and validation of the complete instrument goes beyond the scope of the present article, this study focuses on the development of scales, particularly scales pertaining to major themes representing quality and PhD processes. Regarding *quality*, scales that address psychological well-being, including items on loneliness, insecurity, exhaustion, and ownership, are reported. One main argument is that well-being is often ignored or downplayed in predominant surveys, such as the PREQ and the PRES, when it is crucial to understanding PhD students' overall experiences (Juniper *et al.,* 2012). Regarding *process*, the study focuses on scales for research environments, including items on collegiality and tone. Studies have convincingly demonstrated that research environments and supervision outmatch most other factors in determining students' successful completion (Bair and Haworth 2005), well-being (Stubb *et al.,* 2011), and satisfaction (Barnes and Randall, 2012).

The validity of a measurement instrument like the QPPQ refers to how well it measures what it is supposed to measure. When assessing the instrument's overall validity, several types of evidence should be considered. *Face validity* concerns whether the scales appear to measure what they claim to measure. An indication of the face validity of the QPPQ would be the degree of congruence between the scales and the items in the QPPQ and the scales and items in other major questionnaires on PhD processes. *Content validity* regards the degree to which the item content reflects the definition constructed in the research literature. *Factorial validity* concerns whether a factor structure is clear, interpretable, and can be replicated in a split-data approach. *Convergent validity* concerns the convergence with theory and earlier findings within the field. This is indicated by scales correlating with variables as expected. *Discriminant validity* addresses the following question: Do variables that should not correlate with the scale score not do so (Abell *et al.*, 2009)? An alternative interpretation of discriminant validity is the extent to which scale scores differ between groups of individuals who are expected to differ (Richardson, 2009). Finally, *criterion validity* is established with scales that correlate with external criterion, not measured by the instrument (Abell *et al.*, 2009).

The overall research question guiding this study was: What is the validity of the Quality in PhD Processes Questionnaire (QPPQ)?

To address this question, the following sub-questions were asked:

(RQ_1) What is the factor structure of the QPPQ (i.e. an indication of factorial validity)?

(RQ_2) Are the correlations between scales as expected, based on prior research on PhD students' experiences of the PhD process (i.e. an indication of convergent validity)?

(RQ_3) Do PhD students' perceptions of research environments vary across PhD programmes (i.e. an indication of discriminant validity)?

Research into Quality in the PhD process

Before reporting on the study's results, a concise review of recent research regarding specific elements of PhD processes is given. One of the most consistent findings within the literature is that research environments have profound effects on the quality of PhD processes. PhD students' experiences in their research environments relate to both successful and timely completion (Lowitts, 2001; Wao and Onwuegbuzie, 2011; West *et al.*, 2011). It has also been convincingly demonstrated that research environments are organised very differently across disciplines (Wright and Cochrane, 2000). Many PhD students experience social or intellectual isolation (Ali and Kohun, 2007), especially within the humanities and social sciences (Bair and Haworth, 2005). PhD students who experience being part of a supportive research environment tend to experience greater senses of integration and belonging (Gardner, 2010; Golde, 2005). Such collaborative research environments are characterised by frequent meetings in which research is discussed (Gardner, 2007; Vekkaila *et al.*, 2012) in a friendly, informal, and non-competitive tone (Provtinak and Foss, 2009). Similarly, such environments are characterised by PhD students collaborating with fellow PhD students (Fenge, 2012) and being treated like junior colleagues, participating in professional and social events (Heath, 2002; Pearson, 2005).

Recently, a number of studies have examined the quality of students' emotional experiences in terms of their psychological well-beings. Research can be an enriching but also a very exhausting experience that is associated with uncertainty and stress (Hyun *et al.*, 2006). Studies have demonstrated that negative emotions, such as burnout and stress, are common among PhD students (Jairam and Kahl, 2012; Stubb *et al.*, 2011). Apparently, loneliness and isolation are especially problematic for PhD students as a group compared to senior academic staff (Ali and Kohun, 2007; Jairam and Kahl, 2012; McAlpine and Amundsen, 2009). Interestingly, research shows that PhD students who find themselves well-integrated in their research environments experience less stress and burnout (Stubb *et al.*, 2011; Vekkaila *et al.*, 2013).

Sample and Methods

Postgraduate education in the Danish context

To acquire a PhD degree at a Danish university, students are required to complete a PhD thesis and a public defence. The PhD thesis can be completed as a monograph or as a summary of research articles. In addition, the completion of PhD studies includes teaching duties, coursework, and placement at a foreign research institution. The majority of work, however, is the doctoral student's independent research under the supervision of one main supervisor and at least one co-supervisor. Teaching duties and coursework equate to 60 ECTS (European Credit Transfer System) points (i.e. one full year out of three). The duration of a PhD programme is normally three years, and candidates can apply for admission if they hold a degree equivalent to the Danish two-year master's degree. In some areas, a four-year PhD programme is offered to students who have completed a bachelor's degree and one year of study at the postgraduate level. The average time to complete a three-year PhD programme is 3.6 years. The most common way of funding a Danish PhD programme is through PhD scholarships, which are three-year full-time positions advertised by research institutions. Tuition is free, and PhD students receive a monthly stipend. In return, students have work obligations (e.g. teaching duties). Another way to fund a PhD programme is by means of industrial PhD fellowships, which are offered through collaborations between private enterprises and universities. Fellows are employed and paid salaries during their studies (http://www.ufm.dk). The majority of PhD students in Denmark are full-time students with monthly salaries, and they are considered members of their staffs rather than students. According to the Statistical Practice of Danish Universities (http://www.dkuni.dk/Statistik/Universiteternes-statistiske-beredskab), from 2004 to 2014, the intake of doctoral students more than doubled, from 4,700 to 9,700.

Participants

Data was collected in 2013. A total of 2,244 active and former PhD students at a large, research-intensive Danish university were invited to join the university's audit of the quality of the PhD experience by completing an online questionnaire. 1,780 PhD students responded to the survey, which equals a response rate of 79%. Response rates only varied slightly between the university's four faculties. Ninety of the 1,780 PhD students were omitted from further analysis because of their failure to provide valid answers to at least 75% of the questions. The sample consisted of 47% male and 53% female PhD students, aged 23 to 61 (M = 31.8, SD = 6.0). PhD students came from the humanities (N = 225, 13%), business and social sciences (N = 230, 14%), health sciences (N = 536, 32%), and natural sciences (N = 699, 41%). Twenty-six percent of the PhD students were non-Scandinavian.

Statistical analyses

To examine factorial validity, both exploratory (EFA) and confirmatory factor analyses (CFA) were applied. For sufficiently large data sets, Bowen and Guo (2012) recommend splitting data in two; one data set for calibration and another for validation; thus, an EFA was performed on the calibration data set first to identify latent dimensions underlying the single, manifest variables. The factor solution was then tested using a CFA on the validation data set. To guide the analyses, the following rules of thumb were

applied. Regarding factor loadings, only items with loadings of .32 and above were interpreted (Tabachnick and Fidell, 2007). Regarding the assessment of model fit in CFA, Hu and Bentler (1999) recommend values close to or above .95 for the comparative fit index (CFI) and the Tucker-Lewis index (TLI), a value close to or below .08 for the standardised root mean squared residual (SRMR), and a value around .06 or below for the root mean square error of approximation (RMSEA). Others have suggested more liberal decision rules regarding model fit. According to Kline (2005), a CFI greater than roughly .90 still indicates reasonably good fit, while RMSEA values between .05 and .08 suggest a reasonable error of approximation. Cronbach's alpha statistics were computed to test the scales' internal reliability. Values above .70 are generally considered acceptable, although it should be noted that the statistic is, in part, dependent on the number of items (Abell *et al.*, 2009). Scale intercorrelations were computed to assess convergent validity. Finally, one-way analysis of variance (ANOVA) was performed to assess the scales' discriminant validity. Statistical analyses were conducted in SPSS version 21.

Results

Prior to analysis, the full data set was screened for influential outliers, missing values, and non-normality. SPSS's Missing Values Analysis (MVA) module was used to assess missing values. In this process, one item ('*In this research environment, research conducted by PhD students is acknowledged although it may not be ground-breaking*') was omitted due to 7.8% missing values. The mean proportion of missing values for the remaining items was 2.0%. Missing values were imputed by means of the Expectation–Maximization algorithm (Tabachnick and Fidell, 2007). The data set was then randomly split into a calibration data set (N = 845) and a validation data set (N = 845). The calibration data set consisted of 52% male and 48% female PhD students from the humanities (N = 113, 13%), business and social sciences (N = 119, 14%), health sciences (N = 263, 31%), and natural sciences (N = 350, 41%). The validation data set consisted of 53% male and 47% female PhD students from the humanities (N = 112, 13%), business and social sciences (N = 111, 14%), health sciences (N = 273, 32%), and natural sciences (N = 349, 41%).

Factor analyses

To uncover latent dimensions in the data, a maximum likelihood factor analysis with promax rotation was performed for 23 items reflecting PhD students' experience with the research environment, as well as items relating to the PhD students' well-being and feelings connected to doing research. Five factors met Kaiser's criterion (eigenvalue > 1). The scree plot showed inflexions that would justify either a three- or a five-factor solution. Compared to the five-factor solution, the solution with three factors was very difficult to interpret. Hence, in the end, the solution with five factors was retained. In the process of finding an interpretable and clean factor solution, one item ('*I feel that I'm in control of the project*') was removed because it did not load substantially on any one component. The subsequent factor analysis was conducted for 22 items. Factor loadings after rotation are shown in Table 1. Items clustering on factor 1 were

interpreted as reflecting PhD students' perceptions of a *collegial research environment*. Factor 2 seemed to reflect feelings of *exhaustion*, while factor 3 covered items relating to feelings of *insecurity*. Factor 4 covered two items involving a *harsh tone* in the research environment. Finally, factor 5 was interpreted as reflecting a sense of *ownership* with regard to the research project.

TABLE 1 ABOUT HERE

To test the five-factor solution as indicated by the EFA (shown in Table 1), CFA with maximum likelihood estimation was performed for 22 items using the validation data set. A model was specified with five factors: *collegial research environment*, *exhaustion*, *insecurity*, *harsh tone*, and *ownership*. The chi-squared test (χ^2 = 1106.7, df = 199, $p <$ .001) indicated poor fit; however, this was expected due to the very large sample. Fit indices (CFI = .882, TLI = .864, RMSEA = .074, SRMR = .068) were less than satisfactory.

This suggested that the five-factor model based on the initial exploratory analysis needed improvement. Inspection of modification indices suggested that allowing covariance between the error terms for the questions '*Do you feel lonely during your day at your workplace?*' and '*Do you feel that you act alone in your project and lack the necessary feedback to make progress?*' could significantly improve the model's fit to the data. This was problematic since both items were part of the same scale. One possible interpretation is that the two items represent a non-specified (sixth) latent factor (Abell *et al.*, 2009). This resonates on a conceptual level. Both items refer to feelings of isolation, which is conceptually different from perceptions of the research environment. Thus, feelings of isolation could be regarded as a distinct dimension in its own right (see, e.g., Janta *et al.*, 2014). Consequently, the model was altered and a sixth factor was defined, labelled *loneliness* (see Figure 1). The CFA was repeated. While the chi-test (χ^2 = 842.9, df = 194, $p <$ .001) still indicated poor fit, the model's fit indices improved significantly (CFI = .916, TLI = .900, RMSEA = .063, SRMR = .054).

FIGURE 1 ABOUT HERE

Table 2 compares the proportion of total variance explained by each factor for the five-factor and six-factor models, respectively. In sum, the five-factor model accounted for 49% of variance in the 22 items, while the six-factor model accounted for 52% of variance. Given the substantial improvement in fit indices as well as the increased proportion of total variance explained by the six-factor model, it was decided to retain the model with six factors.

TABLE 2 ABOUT HERE

Scale properties

Returning to the full data set (*N* = 1,690), six scales were computed based on EFA as well as the changes suggested by CFA. Table 3 shows the scales' statistical properties.

TABLE 3 ABOUT HERE

Scale interrelationships

In order to assess the instrument's convergent validity, correlation coefficients between scales were computed and reported in Table 4.

TABLE 4 ABOUT HERE

Group differences

With regard to discriminant validity, variation across PhD programmes concerning perceptions of the research environment was examined. One-way ANOVA showed that PhD programmes differed on the *collegial research environment* scale (F[38, 1633] = 8.44, $p < .001$, $\eta^2 = .164$). In addition, it was found that, on average, PhD students within the natural sciences (M = 4.24) and health sciences (M = 4.40) scored higher on the *collegial research* scale than did PhD students in the humanities (M = 3.77) and social sciences (M = 3.72) (F[3, 1669] = 63.4, $p < .001$, $\eta^2 = .102$).

Discussion

The aim of the present study was to assess the validity of the QPPQ and to report specifically on items relating to the research environment, as well as psychological aspects of the PhD experience. Overall, the QPPQ fared quite well with respect to indicators of validity. The complete questionnaire was based on a comprehensive review of theory and research relating to PhD processes, which strengthens content validity. Furthermore, face validity was enhanced by collaborating closely with PhD students, PhD supervisors, and heads of PhD programmes across a number of PhD programmes and research disciplines when developing the questionnaire. As a result of both exploratory and confirmatory factor analyses, six scales were developed. A clear factor structure and acceptable model fit suggested factorial validity, although a number of scales could be strengthened by incorporating more items. Additionally,

based on confirmatory factor analysis, it was decided to construct a separate scale labelled *loneliness*. This modification of the model should be confirmed in an independent data set. The scales are discussed in greater detail below.

One of the strongest and most interesting scales was the *collegial research environment* scale, comprising nine items. Concerning content validity, the scale covered items about presenting research, sharing joy in research, interacting with fellow PhD students, openness, and collegiality. The scale therefore covers characteristics of a collegial research environment as described in numerous prior studies (Gardner, 2010; Golde, 2005; de Valero, 2001). Factorial validity was indicated by moderate to strong correlations between the latent factor and the nine items, a clear factor solution, and strong internal reliability. Negative correlations between the *collegial research environment* scale and scales regarding *exhaustion* and *loneliness* are consistent with prior research (Pyhälto *et al.*, 2009), which is evidence of convergent validity. In line with other studies (Wright and Cochrane, 2000; Golde, 2005), it was found that PhD students' perceptions of the research environment varied significantly between PhD programmes, which is a sign of discriminant validity. Taken together, the *collegial research environment* scale seems to be a robust and conceptually sound scale. However, on a conceptual level, it can still be debated whether the *collegial research environment* scale covers two dimensions. While most of the nine items clearly refer to PhD students' *perceptions* of the research environment, two items could be interpreted as concerning their *feelings* of being integrated ('*Here I feel respected as a co-researcher*'; '*I feel like I'm part of the research community here*'). On the one hand, it could be argued that perceptions of the research environment and feelings of being integrated are intertwined to such a degree that they are, de facto, identical. On the other hand, the point could be made that perceptions of a collegiate research environment are a prerequisite of the PhD students' feeling integrated as researchers, which would imply that perceptions of the research environment and feelings of integration are distinct constructs. The last mentioned interpretation is in line with findings from a study by Pyhälto *et al.* (2009) in which the authors concluded that PhD students perceiving themselves as members of the scientific community were also most satisfied with the atmosphere of their research environment. As with this study, the authors wonder about the link between the concepts of students' membership position and the atmosphere of the learning environment. One direction for further research would be to develop more items covering feelings of integration and to statistically test models in which the two constructs appear separately.

Another scale closely related to the *collegial research environment* scale is the *loneliness* scale, comprising two items. One item concerns a social aspect of loneliness ('*Do you feel lonely during your day at your workplace?*'), while another item is about being alone on an academic level ('*Do you feel that you act alone in your project and lack the necessary feedback to make progress?*'). In the exploratory factor analyses, these two items loaded with the factor labelled *collegial research environment*. However, later analyses suggested that the hypothesised model could be significantly improved when the two items were specified as representing a distinct factor, which was labelled *loneliness*. Again, on a conceptual level, it can be debated whether perceptions of a

collegial research environment are distinct from feelings of acting alone in a project. Feelings of being alone with the project are probably more related to supervision than perceptions of the research environment because academic loneliness is essentially caused by lack of feedback from, for example, the supervisor.

Two items concerning negative feedback and a competitive environment loaded on a factor labelled *harsh tone*. As expected, a strong and negative correlation was found between the *collegial research environment* scale and the *harsh tone* scale. However, it is interesting that, in this study, perceptions of a collegial research environment and perceptions of the tone between researchers appeared to be separate factors. This suggests that while a constructive tone is likely to be associated with a collegial research environment, some PhD students may not necessarily experience a harsh tone as non-collegial.

Two scales, *insecurity* and *exhaustion*, related to the PhD students' psychological well-being. The exhaustion scale is about feelings of stress and handling a work-life balance as a PhD student. As expected based on earlier research (Pyhälto *et al.*, 2009; Juniper *et al.*, 2012), exhaustion was positively correlated with insecurity. This finding underscores a concern often put forward in the literature about the challenging process of becoming confident as a novice researcher. Suffering from self-doubt and lack of confidence is per se a stressful experience. Whilst some degree of insecurity is an inherent part of a research process, the findings in this study point out the crucial role played by the senior research community to offer reassurance when PhD students experience inevitable let-down in their project. In line with prior research (Marsh *et al.*, 2002; Pyhälto *et al.*, 2009), it was found that the research environment greatly influences PhD students' well-being. Both scales (insecurity and exhaustion) were negatively correlated with perceptions of a *collegial research environment.* Finally, the two scales accommodate Juniper *et al.'s* (2009) call for items on well-being in questionnaires aimed at PhD students because these items highlight aspects which are important to the respondent population, whereas large national distributed questionnaires such as PREQ and PRES focus more on the interests of the institution.

The last scale, labelled *ownership*, included four items: feeling ownership, importance of making one's own choices, not feeling like an assistant to other researchers, and excitement about the project. Statistically, this scale appeared rather weak. In the confirmatory factor analyses, squared correlations between the latent and manifest variables were only moderate in magnitude, and the internal reliability statistic was less than satisfactory. In particular, the item about importance of making one's own choices showed a weak correlation with the latent dimension. Maybe it is self-evident for many PhD students that it is important to make all the critical choices in one's project alone, and therefore this item may have contained too little variation to be integrated into the scale meaningfully. Despite statistical weaknesses, it is nonetheless interesting that the correlation analysis showed statistically significant effects of integration into a collegial research environment on the feeling of ownership (Table 4). The finding is particularly interesting because the correlation contradicts a predominant assumption. In a recent review of doctoral supervision literature, Bastalich (2017) concludes that there is an

assumed relationship in the literature between students working alone and their feelings of ownership. She criticises the existing research for not providing explicit support for the assumption that ownership is undermined by too much help from supervisors and support from colleagues. Our findings contribute to this discussion by suggesting that social as well as academic loneliness are in fact problematic. Within a socialization perspective, the finding makes sense. Academic socialization is a process in which students gradually learn the knowledge and skills in the discipline and take up a research identity by means of interaction and relationships with faculty and peers (Boud and Lee, 2005). Within this perspective, high-quality research is not a discovery that arises from isolated individual minds but is situated within and defined by disciplinary traditions and academic standards. Thus, ownership, independent thinking, and originality involve interplay of the individual, the group, and the knowledge context.

The study's strengths and weaknesses

Analyses in this study were carried out on a large data set with a high response rate, which allowed for calibration as well as validation of the proposed factor structure. Furthermore, the heterogeneous sample represented a multitude of PhD programmes across four major research domains. Compared to exit surveys (surveys in which only PhD students having completed their degree are included), the cross-sectional survey reported here included PhD students at the beginning, middle, and end of the PhD process.

Concerning limitations, the sample only represented one university in a Scandinavian context. In Scandinavian countries, PhD students are paid and regarded as full staff members with everything that entails in terms of rights and obligations (Swedish National Agency for Higher Education, 2006). In addition, PhD programmes are often demanding in terms of very structured coursework, teaching duties, etc. It is reasonable to expect that salary, position, and consequently demands at the workplace influence students' feelings of well-being and integration. Thus, scales and the six-factor model should be validated in independent samples in other, preferably non-Scandinavian, contexts. It was also noted that three of the scales reported on only covered two items, which may have contributed both to lower fit statistics (Harrington, 2009) and lower internal reliability. More items relating to these scales should be included and tested in future research. Finally, no external measure of success was available; consequently, criterion validity could not be assessed.

Conclusion and perspectives

Based on international research on PhD processes, prior survey instruments, and statistical analyses of a large data set representing a multitude of academic disciplines, this study offers a number of scales covering key aspects of the PhD experience. In particular, the scales concerning the research environment and exhaustion are promising because they are congruent with existing research literature and show robust psychometric properties. In line with Barnes and Randall (2012) and Sampson *et al.* (2016), it can be recommended that graduate schools or programs conduct their own assessments in order to better understand their students' experiences and to provide

targeted academic development support. The QPPQ may very well be an inspiration for those who set out to undertake formative assessment of the PhD experience in their particular setting or programme. The QPPQ and its scales also offer a promising instrument for future research into the postgraduate research experience.

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Appendix: QPPQ scales

The complete questionnaire in full detail is available online: https://goo.gl/aj7Ept

Collegial research environment (a = .903)

1. There is a sense around here that working together on research is fun
2. I feel like I'm part of the research community here
3. Here we present and discuss each other's research on a regular basis
4. The scientific staff members are generally interested in hearing about my project
5. Here I meet other PhD students with whom I can exchange ideas
6. If you have any problems related to the PhD programme, you are always welcome to ask one of the other researchers
7. Here I feel respected as a co-researcher
8. Here both PhD students and professors are welcome to share their opinion
9. It is possible to talk openly with colleagues about successful as well as unsuccessful experiences

Insecurity (a = .800)

10. I often feel insecure that what I do is good enough
11. Sometimes I wonder if I'm good enough to be a PhD student

Harsh tone (a = .663)

12. People seem to be very competitive
13. I feel that the researchers here are harsh and negative rather than constructive when giving feedback on each other's work

Exhaustion (a = .811)

14. Do you feel that your work as a PhD student takes up so much time and energy that it affects your private life?
15. Do you sometimes feel worn out?
16. Does your work as a PhD student give you severe stress symptoms?

Ownership (a = .594)

17. I feel a sense of ownership of my project
18. It is important to me that I make all the critical choices in my project
19. Sometimes I feel that I'm nothing but an assistant to someone else's project
20. I think that my project is very exciting

Loneliness (a = .715)

21. Do you feel lonely during your day at your workplace?
22. Do you feel that you act alone in your project and lack the necessary feedback to make progress?

Interpersonal relation with supervisor (α = .808)[a]

1. The relationship between my supervisor and me is characterised by mutual respect
2. I can openly discuss all problems with my supervisor
3. My supervisor recognises my work
4. My supervisor listens to how I want things to be
5. My supervisor asks me about my needs and expectations regarding supervision
6. Sometimes I have a feeling that my supervisor sees me primarily as a source of labour to advance his/her research (reversed)

Directive supervision (α = .768)[a]

7. My supervisor has clear preferences for the direction my project needs to take
8. My supervisor makes many important choices in my project
9. My supervisor has a clear expectation that I will follow the advice I get
10. My supervisor often sets the agenda for the supervision
11. My supervisor sets benchmarks and tells me what I need to do

Non-Directive supervision (α = .594)[a]

12. My supervisor leaves it up to me to take the initiative for supervision
13. My supervisor leaves the control of the project to me
14. My supervisor encourages me to work independently

[a] Scales about PhD supervision are reported in Wichmann-Hansen and Herrmann, 2017

Table 1. Pattern matrix for the five-factor solution (maximum likelihood extraction, promax rotation).

Items	Factors				
	F1	F2	F3	F4	F5
There is a sense around here that working together on research is fun	.85				
I feel like I'm part of the research community here	.81				
Here we present and discuss each other's research on a regular basis	.80				
The scientific staff members are generally interested in hearing about my project	.77				
Here I meet other PhD students with whom I can exchange ideas	.75				
If you have any problems related to the PhD programme, you are always welcome to ask one of the other researchers	.68				
Here I feel respected as a co-researcher	.64				
Here both PhD students and professors are welcome to share their opinion	.58				
Do you feel lonely during your day at your workplace?	-.51				
It is possible to talk openly with colleagues about successful as well as unsuccessful experiences	.49				
Do you feel that you act alone in your project and lack the necessary feedback to make progress?	-.47				
Do you feel that your work as a PhD student takes up so much time and energy that it affects your private life?		.85			
Do you sometimes feel worn out?		.81			
Does your work as a PhD student give you severe stress symptoms?		.69			
I often feel insecure that what I do is good enough			.97		
Sometimes I wonder if I'm good enough to be a PhD student			.68		
People seem to be very competitive				.66	
I feel that the researchers here are harsh and negative rather than constructive when giving feedback on each other's work				.56	
I feel a sense of ownership of my project					.75
It is important to me that I make all the critical choices in my project					.50
Sometimes I feel that I'm nothing but an assistant to someone else's project					-.44
I think that my project is very exciting					.43
Rotation SSL	6.46	3.68	3.16	3.21	1.95

Notes: Loadings < .4 are omitted for ease of interpretation. SSL: Sum of squared loadings

Table 2. Proportion of total variance explained by each factor for the five-factor model and six-factor model respectively.

Scales	Five-factor model	Six-factor model
Collegial research environment	24%[a]	21%[b]
Loneliness	-	5%
Insecurity	6%	6%
Harsh tone	5%	5%
Exhaustion	8%	8%
Ownership	6%	6%
Total variance explained by model	49%	52%

Notes: Proportion of total variance explained by each factor are calculated as the sum of sum-of-squared loading (SSL) for items related to the factor divided by the total number of items included in the confirmatory factor analysis. [a] Factor including 9 items. [b] Factor including 7 items.

Table 3. Descriptive statistics for scales reflecting PhD students' research experiences.

Scale	Sample item	Items	*M*	*SD*	Skew	α
Collegial research environment	*There is a sense around here that working together on research is fun*	9	4.16	.82	-1.21	.903
Loneliness	*Do you feel that you act alone in your project and lack the necessary feedback to make progress?*	2	2.22	1.02	.64	.715
Exhaustion	*Do you sometimes feel worn out?*	3	2.73	.89	.26	.811
Insecurity	*I often feel insecure that what I do is good enough*	2	3.31	1.31	-.32	.800
Harsh tone	*I feel that the researchers here are harsh and negative rather than constructive when giving feedback on each other's work*	2	2.21	1.07	.68	.663
Ownership	*Sometimes I feel that I'm nothing but an assistant to someone else's project (reversed)*	4	4.26	.63	-1.06	. 594

Notes: Scale range: 1-5.

Table 4. Bivariate correlation coefficients between scales (Pearson's *r*).

	1	2	3	4	5	6
1. Collegial research environment	1					
2. Loneliness	-.590**	1				
3. Insecurity	-.254**	.384**	1			
4. Harsh tone	-.430**	.347**	.198**	1		
5. Exhaustion	-.335**	.465**	.369**	.318**	1	
6. Ownership	.141**	-.214**	-.249**	-.041	-.124**	1

Notes: *p < .05, **p < .01

Figure 1. Six-factor model