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## Construction of scientific knowledge and meaning: perceptions of Portuguese doctoral students

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### Abstract

This research focuses on how doctoral education is promoting, or can promote, levels of cognitive and psychosocial development that allow students to solve problems in creative, autonomous and cooperative ways. This goal is considered highly relevant for doctoral education, given its focus on the production of scientific knowledge. Following a qualitative design we analyse the preliminary results of a group of interviews carried out with recent PhD holders aimed at eliciting their retrospective thoughts about the PhD experience and the cognitive and psychosocial gains arising from this process.

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### 1. Introduction

The recognised lack of studies on monitoring and evaluating the quality of doctoral education has led to difficulties in designing quality assurance systems for this level of studies (Brooks & Heiland, 2007; O'Carroll et al., 2012), yet these difficulties can only be overcome when the competencies instigated in this level of education are clearly defined. In research-based doctorates, the type that leads to the PhD title are the most common ones and also the most socially and academically prestigious (Parry, 2007). These competences refer to the production of scientific knowledge.

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In this paper we will focus on this type of doctorate which aims at equipping the individual with a high level of competence in knowledge, creativity and leadership, whilst providing valuable scientific outputs for the stock of research knowledge within research groups and universities. These goals are corroborated by the Dublin descriptors (2004) for the third cycle of Bologna, since it is expected that students may reach the cognitive and psychosocial development levels necessary to solve problems in creative, autonomous and cooperative ways.

Though the development of superior cognitive structures and psychosocial features (as, for example, autonomy) is widely seen as important for the quality of the research process, it is a process of slow and gradual development. Several studies alert to the fact that most graduate students do not achieve the highest levels of cognitive development (Perry, 1981; King, Kitchener & Wood, 1994). Despite the scarcity of research focusing on doctoral students (Gardner, 2009), the studies conducted so far highlight that only a small number of doctoral students will attain the highest levels of cognitive development, specifically epistemological complexity (King & Kitchener, 2004; King, Kitchener & Wood, 1994). Although the slowness underlying this developmental process, it is of common agreement that it is mainly facilitated by formal educational contexts and on the continuation of studies (Creamer, 2010; King & Kitchener, 2004).

Cognitive or intellectual development as it is considered in this research, can be viewed in two perspectives: (1) the ability to solve ill-structured problems, questions that do not have a one-and-simple resolution and can only be addressed using different strategies and knowledge approaches; (2) attitudes and beliefs about knowledge and learning.

The first perspective focuses on the reflexive judgment model proposed by King and Kitchener (2004) and assumes that the development of individuals starts with a dichotomous vision of knowledge (right or wrong) held by authority figures. In the final stages of the model, adults understand knowledge as something grounded in valid arguments (implying self-commitment) and which is defined both by the circumstances and the contexts people are involved in.

The second perspective concerns the Schommer-Aikins and Hutter (2002) approach, where the developmental process is seen as the progress leading to a more flexible and self constructed view of both knowledge and learning.

At the same time, psychosocial autonomy is widely accepted as a crucial step for students to become more critical and able to achieve more complex levels of intellectual development (Chickering & Schlossberg, 2003; Gardner, 2009). Thus, students should envisage both the process of knowledge construction and the approaches to problem solving or critical positioning as internal to themselves. These rationales seem to be very close to Chickering and Schlossberg's (2003) definition of psychosocial autonomy as being able to relate and bound with significant others whilst keeping a sense of self and of individual choices and views.

One more integrated position assumes the integration of high levels of cognitive and psychosocial development bestowing the students (specifically, the adult learner) with the competence to be authors of the knowledge, identity and relationships they construct. This competency is called self-authorship (Baxter-Magolda, 2009) and seems to be closely related to what is expected from a doctoral student: to be able to construct new scientific knowledge sustained by his critical view about the state of art in his research domain. Hence the construct being defined as a "holistic meaning-making capacity (...) that is characterized by internally generating and coordinating one's beliefs, values, and internal loyalties" (Baxter-Magolda, 2009, p.4). Moreover, and as is highlighted by Baxter-Magolda, self-authoring individuals assume internal and external responsibilities for their thinking, feeling and acting.

According to Walker et al. (2007), the centrepiece of doctoral education is learning, since it meets the purpose of breaking down new grounds and building new knowledge. Therefore, the emphasis should be on investing, risk-taking and putting the abilities to work. For this to succeed it is fundamental to have stimulus and embrace the challenge of breaking down the "comfort zone", as pointed out by many developmental scholars. For cognitive and psychosocial development to occur it is necessary stimuli and challenges. The accomplishment of these complex learning goals should not only promote cognitive development but also be grounded in it. However, achieving success in any challenge requires support.

Gardner (2009) position extends this last idea considering that for doctoral students to achieve success in their challenges support must be planned and available. Upon an extensive literature review on the college students' development and on adult learning theories, Gardner (2009) offers a three-fold model for development of a doctoral student. This model frames phases representing three stages during the development of a doctoral degree. These

same phases, each one integrating challenges and sources of support students may encounter. The first stage – Entry – corresponds to their arrival at a higher education institution, getting to know what is expected of them and establishing relationships with peers and faculty staff. The second stage – Integration – refers to the moment of developing their research and consolidating their role in the lab, research centre or institution, as well as strengthening relationships. The third stage – Candidacy – reports to the systematization of the doctoral dissertation writing process, the interpretation of research findings that support original scientific knowledge construction.

Constructing scientific knowledge and making meaning out of the experience of attending a doctoral degree is what makes this cycle unique, whilst meeting the guidelines for the 3<sup>th</sup> cycle of Bologna. It is not expected that different students integrating diverse trainings, as the ones offered in doctoral degrees, follow the same path or experience the same challenges. For instance, different school backgrounds, personal and family experiences and even different ages come to the surface when dealing with doctoral challenges (Gardner, 2009). This generates a two-fold problem: on the one hand it is necessary to bear these specificities in mind both by the programs or courseworks, and in particular by the supervisors; on the other hand, different challenges and different answers to these challenges have to lead to the same developmental processes.

The supervisor role and the relationship established with student are widely pointed to in literature as the most important factor determining the success and attrition of doctoral students (Gardner, 2007; Parry, 2007). According to the review of the literature, Gardner (2007) points out five aspects that supervisors are expected to fulfil: (1) accessible to students, (2) providing regular, positive feedback on their progress, (3) showing care and concern, (3) being credible and trustworthy, (4) treating students as colleagues or equals and (5) being supportive. Students, in their turn, are expected to deal with the tensions of being “stuck-unstuck” and to face the challenges and difficulties within the doctorate. For that purpose, supervisors must give them the space to work alone when they have to do it and give support when needed (Baptista, Huet & Jenkins, 2011; Kiley, 2009; Trafford & Leshem, 2009).

Another issue concerning doctoral education is the question of whether different scientific domains have different impacts on internal knowledge construction. The differentiated scientific cultures within the scientific domains are recognised, yet there is a lack of consensus on what impact these aspects have on the development of the doctoral student (Parry, 2007).

This paper presents part of a research project that aims to evaluate the impact of doctoral degrees in the development of students enrolled in different phases of the Bologna 3<sup>th</sup> cycle. This project is also concerned with developing instruments to assess the quality of doctoral programmes concerning the development of competencies established by the Bologna guidelines.

Despite the wide number of studies, in the last two decades, regarding cognitive development constructs, difficulties remain in providing valid and robust quantitative instruments (DeBacker, Crowson, Beesley, Thoma & Hestevold, 2008; Baxter-Magolda, 2010).

In the present work, we collect qualitative data from PhD holders about their experience as students and their perceptions of scientific meaning construction during the years of doctoral education. The collected evidences may contribute to the adaptation of some instruments, the ones most used at international level, to the Portuguese context and to the specific features of Portuguese doctoral education.

## 2. Method

The research approaches that better suite our purposes are based on a qualitative method, using interviews as the data collection procedure, following a retrospective design (Johnson & Christensen, 2004). This design allows us to access the whole experience of the doctorate process, whilst avoiding the focus on the perceptions and feelings that could be more activated in the students at the moment of the interview. Moreover, since the PhD holders who participated in our study have finished their doctorate within the last year, the experience is expected to still be very accessible in their memories.

With this design we intend to fulfil the following research aims:

- (1) To understand how PhD holders perceive their personal construction of meaning;
- (2) To understand the personal beliefs about knowledge construction;
- (3) To understand how students perceived themselves in the process of scientific knowledge construction;

- (4) To understand how they perceived the process of constructing autonomous working conduction and knowledge construction;

The answer to this fourth question generated interesting evidences which led us to ask a futher three specific questions:

- (1) What is the sort of challenges mentioned by the interviewees?
- (2) Are these challenges common among interviewees?
- (3) Do these challenges differ according to the scientific domain of the interviewee?

The analysis of these questions is still preliminary since the extensive analysis requires a step by step approach, the first step being the object of analysis in this paper.

## 2.1 Participants

The participants are PhD holders who have finished their doctoral degree within one year, with the following distribution in the four scientific domains: Natural and Exact Sciences (NES - n=5; 25%), Engineering (E - n=5; 25%), Social and Human Sciences (SHS - n=5; 25%) and Heath Sciences (HS - n=5; 25%). These 20 participants are from different doctorate studies (before and after Bologna, with and without doctoral courses) of 3 research-intensive Portuguese universities (University of Aveiro, University of Coimbra and University of Porto). Fourteen (n=14; 70%) are females and 6 are males (30%), their ages ranging from 27 to 52 years old, with a mean age of 34.5 (SD=6.5). Seventeen (n=17; 85%) had a scholarship or other form of funding and 15 (75%) were full time students.

## 2.2. Instrument

The data collection procedure was a semi-structured interview with a length of approximately 60 minutes, which aimed at accessing each participant's story regarding the doctorate process and significant moments. They were asked to think about those moments and to express themselves in relation to the following aspects: (1) Why were these moments important; (2) What they thought during those moments, (3) How they coped with those moments and (4) What emotions were triggered.

Besides these four aspects, the protocol focused on gathering these Phd holder's perceptions of how they see themselves as students (persons who learn and need to accomplish educational goals) and about the scientific construction of knowledge in their specific scientific domain. Questions about the relationship with the supervisor, peers and other sources of social support were also conducted.

The protocol for the interview, adapted from three other protocols used in previous studies, was constructed to access specifically recent Portuguese PhD holders' experiences. Three protocols were the basis for constructing the used instrument.

- (1) Perry's (1981) seminal work and the open interview with one starting question "What has stood out for you during the last year?" that lead students (graduation students) to talk about their experience as college students and learners.
- (2) The Baxter-Magolda (2004), first semi-structured interview where she started with Perry's question but also addressed the different roles they are involved in (as students, as peers, etc.) and a specific question about the nature of knowledge and how they think their decision making.
- (3) Baxter-Magolda's (2010) instrument regarding the assessment of self-authorship, that focus each moment that is identified by the interviewee as important (either negatively or positively). Regarding those moments it is to ask: (1) How they feel about it, (2) How they make meaning out of it; and (3) What is the role of significant others.

Our instrument has a flexible structure that can lead individuals to explore their experience and think about the different aspects they identified as important or that led to transitions.

## 2.3 Procedure

The data was collected between March and June of 2012. All participants were contacted by email or telephone and informed about the objectives and length of the interview and asked to collaborate. All interviews were conducted face to face and following ethical procedures the goals were explained and it was emphasized that participation was

voluntary and all answers were confidential and used for the purpose of the present study only. All individuals were asked permission for recording and all of them accepted.

### 3. Results and discussion

The first analysis of the collected data shows great diversity of experiences, and also a lack of consensus about the moments considered important or challenging. If for some of the respondents writing was a difficult, anxiety-generating and lonely task, for others it was a stage they simply had to complete. Also, for at least one of the interviewees, the writing task was considered one of the most positive moments, as it corroborated by the following quote

*“I guess they are moments of work completion (...) it is a way of seeing that your results can tell a story and that gives you a great intellectual joy”* (E8, NES, age 38).

Almost half of the participants reported a hard time during the first year when getting started with the literature review and becoming acquainted with field-specific knowledge. Such moments are depicted in the speech of a PhD holder in SHS:

*“In the beginning I read a lot of stuff that didn't have any interest. My initial research topic was not what I did afterwards and my main supervisor couldn't help me either. It was such a solitary work. But I guess in the end I gained a shell that allowed me to select what I needed and write in a more consistent way...But in the beginning I felt completely lost”* (E7, SHS, age 38).

A similar experience is mentioned by another respondent:

*“In the beginning it was hard, very hard. My PhD is basically on Atmospheric Chemistry so I had to know a lot of organic chemistry which is a very specific domain within chemistry. I had a subject in the degree that was very general, General Chemistry...And so in the beginning of the PhD I had to study a lot...the first year, I think...but it was at the beginning of the second year that I started to truly realize what I was doing”* (E4, E, age 34).

The diversity of experiences is already noticeable across scientific domains. Thus, the first conclusion to be drawn is that the experience of the development might be less dependent on the scientific domain than on the students' personal characteristics, the courses and the relationship established with supervisors.

One of the core features in developing higher levels of cognitive development is the awareness of being more autonomous in conducting own work and in the decision-making process. This requires the supervisor to facilitate the process increasing autonomy, by giving feedback that can boost self-confidence and supporting the decisions made, while making room for some disorientation and anxiety (Gardner, 2009; Baptista, Huet & Jerkins, 2010). This assumption is quite clear in the words of one participant of the present study:

*“One time my supervisors weren't able to answer my questions (doubts)...and then I thought I had to manage ... and to get information from one or another who might be knowledgeable but who were not my supervisors. I have the perfect notion when I internally realized this ... it was not pleasant to realize that I had to work that way from that moment on. But on the other hand, when I realized it should be like this it ended up being good...because it stimulated my becoming more independent (...) It was uncomfortable at the time...I was uncomfortable with the situation, because I realized that I wouldn't get the support I wished I had...but I work by setting goals and I knew where I wanted to arrive...so I stumbled for a while thinking and integrating internally these ideas (...) I did not blame anyone because there was neither the knowledge nor the time”* (E8, NES, age 38).

Another student tells us about the construction of an autonomy structure but without the support she thought was the supervisor's duty. Instead, in this particular case, the support came from the team of lab peers:

*“We were very autonomous, or rather we were made to be, do you see? And... Yes, there was some support but the first approach was throwing us to the wolves, ‘you have to write an article for this conference that's going to happen,’ the first article was more supported, there was more revision from one of them... and then gradually we started to be able to, to be more confident of, for example, we'd have an article for a conference, if they didn't have time to review it, we'd submit it anyway to meet the deadline. But I think the process of writing was, once again, a question of, in the group, those three people, help ourselves out, of... we'd write and then each one give their opinion, one was better in English, another thought the graphics weren't right, and it was a bit...but in the beginning, the process of starting an article was a bit... ‘to the wolves’, we wrote the article and only after was there any interaction. But we also thought that the fact we were trying to write an article from beginning to end*

*without great impulses that we would become more autonomous, at least I now see it a bit like that, at the time I didn't like it at all of course, but now I think I see it like this... I guess they always promoted autonomy... that is transversal to all the topics. Autonomy was always... of course if you ask whether I think it was right, I think in the first year I think it shouldn't be so... students have to be autonomous by the end of the process or better from the middle onwards; they should be more supported, but there it is, they have a thousand and one things to do and sometimes don't have time for us, right, and... and so we try to complement with our colleagues who are in the same situation as us"*(E3 – NES- age 28).

Contrary to the two previous statements is the feeling expressed by another participant of not being autonomous and total responsible for the decisions made during the doctoral degree process, particularly during the writing of her thesis. This idea is exemplified in the following quote:

*"I always felt that my decisions had some importance but most of the time it was my supervisor's ideas which prevailed...not mine. Yes, the ideas were more hers...like the one about an article. The thesis was mine...and my professor [person who reviewed the final thesis] argued: "-it is your thesis, how can you put this article there?" and I replied "-you are absolutely right, but I was forced to add the article". And the truth is that she wanted me to include the article and no matter what I argued, she thought that I should add it and I did as she wanted. Maybe I could put my foot down about it. So, in some things what happened was she turned out to be the one who decided"* (E4, E, age 34).

However, the challenges reported, like any other challenges, can only promote development if they are not too big and if they are understood as opportunity (Stanford, 1966). Thus, in this process both the students' expectations and the support they can get must be taken into account. Consequently, if challenges are set, it should be clear for both student and supervisor the role that is expected from one another.

Some participants describe the process as too lonely, and the lack of (expected) support (whether at the scientific or at the personal level) from the supervisors makes it even harder. For these interviewees the challenges encountered were regarded as high obstacles. Nevertheless, some respondents felt very comfortable when the supervisors were absent during the PhD process, maintaining however a relationship of trust. This is the case of 2 participants working in higher education institutions with aged 43 and 42 and who had to complete the doctoral degree for career purposes. They refer that this absence turned out to be comfortable for them, as they were able to decide exactly what they wanted (E17 E and E19 HS).

For some respondents the lack of guidance from the supervisor was perceived as "quicksand", as if they were not standing on solid ground. They felt lost and not able to explain research results or decide the next step. One participant even admitted that when her supervisor was abroad for a year she decided to give up on her PhD:

*"I felt like I wasn't doing anything and was completely out. I had lost my two supports [Supervisor and boyfriend] and wasn't doing anything. It was at the end of the second year. (...) I did not have the support from my supervisor that guided me and I was not contributing with anything at all and I was just 'occupying space' and earning money I didn't deserve (...). [When she returned] she told me I could do it, that I was capable and I got more energy and started doing the experiments again. And it made things different, she was already here, and she guided more. She gave me strength"* (E14, HS, age 33).

The doctoral challenges can arise from the research work students are developing, from the adjustment of their own expectations, from their personal characteristics. The coursework and the relationships with supervisors or peers can also act as triggers. Nonetheless, what seems to be more important in these interviews is what has been a good challenge for one person might not be to another. And the most daring goal in this level of education, accomplishing the principle of promoting the cognitive and psychosocial development that allows students to solve problems in creative, autonomous and cooperative ways (Dublin, 2004), requires us to bear in mind each person's needs. In our opinion, this is why the relationship with the supervisor becomes so central, because it bears an important part of the responsibility of guaranteeing these educational goals. For their part, institutions must also be very much aware of the competences they want to promote on their PhD students in order to design coursework that can assure it.

Looking upon the doctoral student development when considering the challenges and sources of support they might encounter or that are planned they face is a possible framework to approach the thematic. This view proposed by Gardner (2009) supported in the extensive literature review on college student and adult development as the value of pointing out for the importance of these two forces that foster development. It also is important for higher education staff to be aware of the type of challenges and the moments when there are most triggered. However, one

must focus on the singularity of the doctoral process, if it is indeed the most tailored formal educational level and it is widely dependent on the students, their main goal persist: to develop the highest levels of cognitive and psychosocial development.

#### **4. Main conclusions**

The preliminary results gathered in the interviews disclose the diversity of paths and experiences during the accomplishment of the 3th cycle of Bologna. The difficulty is noticeable, at least in some interviews, in accessing the cognitive processes that are thought to be the core development focus in higher education levels.

However, the deeper we explore the way doctoral students and recent PhD holders express their understanding about the processes of knowledge construction, the more accurately we can design quantitative and/or qualitative instruments for measuring important educational competencies acquired by the students. And for a holistic quality assurance system in doctoral education both the design of a comprehensive framework and of valid measures is necessary. This interview protocol allows for the exploration of the key-moments identified by recent PhD holders concerning the process of developing their doctoral studies. It also gives us the possibility of exploring the cognitive process of decision-making and the reasons students point out to be the most distressing or thrilling ones. It also allows for a wider perspective of their evaluation on the process of knowledge construction and aspects they perceive as supporting or hampering it.

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