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The relationship between teaching and learning conceptions, preferred teaching approaches and questioning practices

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This paper focuses on the relationship between preferential teaching approach (PTA) and the concept of teachers' questioning practices (TQP), as part of a large-scale three-year project aimed at developing the scholarship of teaching and learning at one Portuguese university. In order to contribute to understandings of how teachers' questioning is connected to teachers' concepts and motivations, two dimensions were considered for analysis: (1) teachers' main changes in their PTA and TQP, when lecturing to undergraduates, during the three years of collaboration; and (2) differences in teachers' PTA and TQP when lecturing students at different academic levels. Data were gathered through observation of master and undergraduate lectures, during the 2009/2010 academic year. All lectures were audio-taped. Fifty per cent of these were fully transcribed and analysed considering TQP. Teachers responded twice to a Portuguese version of the revised approaches to teaching inventory, one for each academic level, and were also interviewed. The results revealed that the four professors maintained their initial PTA and the corresponding teaching and learning conceptions for both dimensions of analysis. However, looking at their TQP some changes were observed. These results could imply that it is 'easier' to 'modify' (over time) and switch (between academic levels) particular teacher practices, such as questioning, than their global PTA, rooted in specific teaching/learning conceptions. The findings of this longitudinal study, bridging two areas of research, enabled recommendations to be made regarding the design of training strategies to enhance reflection on high-quality teaching and learning processes.

Keywords: preferential teaching approaches; teaching and learning conceptions; questioning; higher education; biology; dialogic interaction

Introduction

Teacher questioning

Research on questioning in education evidences that teacher's questions are an important 'device' in a teacher's 'pedagogical tool box' (Chin and Osborne 2008; Macaro 2005). Indeed, teacher's questions can be used for many purposes such as to make students listen carefully (Sahin 2007), to initiate a discussion, to review material or to organise specific learning tasks (Watts and Pedrosa-de-Jesus 2006). By using questions, the teacher might encourage students to explain their thinking and to elaborate new reasoning based on their expressed thoughts (Chin 2007). Therefore, several studies, using data gathered from basic to higher education, particularly in the domain of science education (Chin and Osborne 2008), have

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been investigating the ‘quality’ of teachers’ questions in order to measure the quality of teaching and learning processes. Research findings reinforce an accepted ‘wisdom’ from basic to higher education in that it is the teacher that formulates the majority of questions with only a small number of them being of a high cognitive level (Dillon 1988; Pedrosa-de-Jesus and da Silva Lopes 2008). However, according to Gunel (2008), even when teachers pose high-cognitive level questions, many display complementary pedagogic behaviour, such as body language, class movement and reduced wait-time for a student question or answer, discouraging them from expressing their thoughts and contributing to discussions, jeopardising learning-quality. Taking this evidence into account, it becomes clear that teacher questioning cannot be reduced only to the cognitive level of the involved reasoning, since it is rooted in the differing knowledge, concepts and beliefs of the teacher (Barak and Shakman 2008).

The work presented here is part of a larger project aimed at contributing to the understanding of how this particular pedagogical tool (teacher questioning) is embedded in ‘being a teacher as a whole person’, who has specific teaching conceptions and adopts particular teaching practices. It is believed that the knowledge obtained through this research can be useful in the design of teaching training strategies focused on enhancing quality learning, contributing, therefore, to the development of the scholarship of teaching and learning.

Research on teaching in higher education

A substantial number of studies report investigations dealing with the concept of teaching styles, or approaches, of university teachers (Kane, Sandretto, and Heath 2002; Postareff et al. 2008). For example, Kember and co-workers identified two distinct conceptions of teaching, namely, teaching as ‘learning facilitation’ and teaching as ‘knowledge transmission’, recognising a strong relationship between the orientation to teaching (‘concept’) and the adopted teaching methods, including the learning tasks and the assessment demands that the teacher adopts (Gow and Kember 1993; Kember and Kwan 2000).

Trigwell and Prosser (1993) and Trigwell, Prosser, and Taylor (1994), based on a phenomenographic analysis of interview transcripts of 24 first-year lecturers, identified two ‘opposite’ preferential teaching approaches (PTAs), in terms of different teaching intentions and teaching strategies, namely, ITTF (information transmission teacher-focused) and CCSF (conceptual change student-focused). Each ‘type’ is rooted in different teaching and learning conceptions (Trigwell and Prosser 1996, 2004). At the ‘teacher-focused’ pole, learning is perceived as ‘information acquisition’ being driven and assessed by external factors to the students, while teaching is focused on the syllabus or the textbook. At the ‘student-focused’ pole, learning is discussed in terms of developing personal meaning through conceptual development and/or change, while teaching is perceived as supporting the students in this process (Prosser and Trigwell 2006; Prosser et al. 2008). The same research group developed an instrument that allows for the identification of the teacher’s PTA in a specific context. The most recent version of this instrument is called the *revised approaches to teaching inventory*, or simply ATI-R (Trigwell, Prosser, and Ginns 2005).

Similar findings, which evidence an internal relationship between ‘teaching conceptions’ and ‘theories of action’, are described elsewhere (Eley 2006; Martin

et al. 2003; Norton et al. 2005; Oosterheert and Vermunt 2001; Samuelowicz and Bain 2001). The majority of these types of study lack empirical evidence from ‘natural’ lecture environments. They consider what teachers *say* about their practice, using information gathered from indirect observation (through interviews, surveys or questionnaires), reporting only ‘half the story’ (Kane, Sandretto, and Heath 2002; Postareff et al. 2008). Consequently, the relationship between teaching conceptions and teaching practices is still unclear (Devlin 2006), which makes it difficult to answer the following questions: Is it possible to change university teachers’ ‘conceptions’ and ‘practices’? If yes, in what order do such changes occur? Does the teacher first change their ‘conceptions’ and then their ‘practices’? Or does this happen the other way around? Or, perhaps, do both change together over a certain period of time? Our intent has been to tackle some of these issues.

Relationship between preferential teaching approaches (PTAs) and teacher questioning practices (TQP) – findings from previous research

The work reported here is part of a project, started in 2007, involving the contributions of four professors, Anna, Beatrice, Charles and David (fictional names), from the Biology Department of a Portuguese university lecturing to undergraduates, in their first year of study, in the specific subject areas of microbiology and evolution.

At the beginning of the academic year 2007/2008, each professor completed a Portuguese version of the ATI-R. The reliability measures, revealing internal consistency (Cronbach alpha over 0.75), have been previously calculated using a sample of nearly 100 teachers (Pedrosa-de-Jesus, da Silva Lopes, and Watts 2009). Two of the professors were identified as being more ITTF, while the other two appeared to have a preference for a CCSF teaching approach (Table 1). Data gathered by interviewing each professor (semi-structured interviews) confirmed the inventory results, and consequently the main teaching and learning conceptions of each PTA (Pedrosa-de-Jesus, da Silva Lopes, and Watts 2008).

In order to identify the teachers’ main practices, particularly their questioning, associated to each PTA type (ITTF vs. CCSF), data collection was mainly based on observation of each teacher during his ‘daily’ lecturing. The observation of ‘authentic’ or ‘real-life’ situations gives a naturalistic approach to this research project (Cohen, Manion, and Morrison 2003; Tuckman 1999). All lectures lasted for two hours and were organised in modules, being attended by nearly 40 undergraduates. The observed lectures were audio-taped and fully transcribed in order to proceed with discourse analysis, considering the number and the cognitive level of teachers’ (and students’) questions. The ASI (acquisition–specialisation–integration) categorisation system (Pedrosa-de-Jesus et al. 2006) was used for this purpose. No clear relationship between PTA and either teachers’ question frequency or cognitive level could be

Table 1. ATI results of the four professors (2007/2008).

PTA	Professor			
	Anna	Beatrice	Charles	David
Poles ^a				
ITTF	4.0	4.0	3.5	3.2
CCSF	3.4	3.7	4.2	4.0

Note: ^aResults based on the mean numeric response for each pole.

identified (Pedrosa-de-Jesus and da Silva Lopes 2009). However, considerable differences were recognisable between teachers with opposite PTAs, in the way they dealt with students' interventions, both answers and questions. Consequently, a categorisation system of teachers' questioning practices (TQP) was developed being rooted in the concept of questioning as a 'joint action' (Clark 1996), rather than a teacher *or* a student activity. The categorisation system (agreement percentage over 85%), integrating the following dimensions, was validated by an informant/respondent debriefing process with all four professors (Pedrosa-de-Jesus and da Silva Lopes 2009):

- (1) the way teachers deal with the absence of a solicited student answer, self-answer vs. reinitiation effort, by repeating or reformulating the previous question, maintaining (=) or lowering (▼) the difficulty level of the previous question; and
- (2) the way (dialogic vs. non-dialogic) teachers deal with student intervention (questions and answers).

According to the adopted definition, adopted from Mortimer and Scott (2003), a teacher is being 'dialogic' when he engages with a student's idea, expressed by a question and/or answer and, consequently, stimulates the student's intellect. A non-dialogic teacher-student interaction, through questions, occurs when the teacher does not explore the student's idea/perspective and/or does not stimulate further reasoning, generating new and shared meaning. For example, after a student's incorrect answer the teacher might 'only' correct it, proceeding then with his explanation, without exploring the reasoning behind that particular answer (Table 2). When the teacher does this, they are adopting a non-dialogic attitude. A more detailed description of each teacher's practice can be found in Pedrosa-de-Jesus and da Silva Lopes (2009).

Findings from the academic year 2007/2008 revealed that the two teachers, identified as being CCSF, have a lower percentage of self-answers than their ITTF colleagues, who tend to have less success in obtaining a student answer (Table 3). Considering the nature of teachers' reactions to students' interventions, it was realised

Table 2. Categorisation of teacher's questioning practices (TPQ) – an example.

Teacher (T)–student (S) dialogue	TQP
T: What is a gene? S: x (no answer)	Initiation effort
T: Well ... what is a gene? If genetics studies the genes ... what is a gene? S: A sequence of nucleotides.	Reinitiation effort (=)
T: A sequence of nucleotides. ... Ok ... it fits ... but that means that ... well, what is a sequence of nucleotides? It is easy to say 'it is a sequence of nucleotides' ... but what does it mean? S: x	Dialogic reaction to student answer
T: Imagine you go to a high school and say a gene is a nucleotides sequence. How do you explain this? S: A group of proteins?	Reinitiation effort (=)
T: A group of proteins? No way [teacher explains by himself what is a sequence of nucleotides]	Non-dialogic reaction to student answer

Table 3. Undergraduates' and teacher behaviour after a teacher question (Year 1).

Professor		Teacher question	Student answer	Teacher reinitiation effort	Teacher self-answer
Anna	<i>M</i>	81	34	18	29
	SD	21.20			
	%	100	42	22	36
Beatrice	<i>M</i>	22	12	6	4
	SD	22.11			
	%	100	55	27	18
Charles	<i>M</i>	87	60	23	4
	SD	32.47			
	%	100	69	26	5
David	<i>M</i>	46	32	11	3
	SD	7.0			
	%	100	70	24	6

Notes: *M*, mean value of five transcribed lectures; SD, standard deviation.

that both CCSF teachers more often had a 'dialogic attitude' to students' answers, when compared with both ITTF teachers (Table 4).

It was clear that there is a relationship between teaching and learning conceptions and the way teachers 'perceive' questions' functionality during undergraduate lectures. For ITTF teachers, questions seem to be an instrument *for* and *of* the teacher, while CCSF teachers use questions to 'explore undergraduates' concepts' and to

Table 4. Types of teacher's reaction to undergraduates' intervention (Year 1).

Professor		Teacher reaction				Student question	Teacher reaction		
		Student answer	Dialogic	Non-dialogic	Other*		Dialogic	Non-dialogic	Other ^a
Anna	<i>M</i>	34	4	30	0	4	0	2	2
	SD	5.0							
	%	100	12	88	0	100	0	50	50
Beatrice	<i>M</i>	12	2	10	0	6	1	5	0
	SD	11.7							
	%	100	17	83	0	100	17	83	0
Charles	<i>M</i>	58	33	25	0	9	3	4	2
	SD	22.3							
	%	100	57	43	0	100	33	42	22
David	<i>M</i>	32	20	12	0	5	2	3	0
	SD	6.2							
	%	100	63	38	0	100	40	60	0

Notes: *M*, mean value of five transcribed lectures; SD, standard deviation.

^aNot identifiable (e.g. the lecture was interrupted, the student intervention wasn't heard or recorded).

‘promote interpretation of sequential information’ (Pedrosa-de-Jesus, da Silva Lopes, and Watts 2009).

The very low number of undergraduates’ questions registered with all four professors, less than 10 questions per lecture (Table 4), reinforces the mainstream literature which points to the ‘passive’ posture of undergraduates, who tend to intervene only when solicited by the teachers and rarely by self-incentive (Pedrosa-de-Jesus and Moreira 2009). These results evidence the urgency of rethinking classroom strategies in order to promote effective and active enquiry environments. Consequently, during the second year of this research project (2008/2009) some innovative teaching strategies were designed in collaboration with the teachers in order to enhance teacher–student interaction during lectures. Each teacher then implemented the designed strategy, such as discussion of the examination papers with students and the study of a specific problem-based case, in his/her own undergraduate lectures (Pedrosa-de-Jesus and da Silva Lopes 2009).

The present research

Aim and research questions

As part of their professional activity, teachers are usually involved with more than one subject, dealing with a wide range of students and contents. Evidence, mainly gathered through indirect observation, claims that approaches to teaching vary from one teaching context to another (Postareff, Lindblom-Ylänne, and Nevgi 2008). However, studies that use empirical evidence collected through direct observation of the same teachers in different teaching-learning contexts is rare (Kane, Sandretto, and Heath 2002).

The research reported here builds on previous work focused on the comprehension of the relationship between PTA and TQP. For the third year of collaboration (2009/2010) with the same group of professors, two new dimensions were taken into account, namely:

- (1) Changes in teachers’ PTA and/or TQP during the research project in the context of undergraduate lectures. The main goal consisted of contrasting data from undergraduate classes of Year 1 (2007/2008) with Year 3 (2009/2010). Considering that data were obtained in two distinct moments, the hypothesis is that the main factor that might have some influence on PTA and TQP is the way teachers integrated their professional experiences, together with the opportunities for innovation and reflection created by the research project.
- (2) ‘Students’ maturity’ (undergraduate and master level). Since the data were obtained during the same academic year, the hypothesis is that the factor that might cause eventual differences between PTA and TQP was the way in which teachers take into account students’ maturity into their way of conceiving teaching and learning in this specific teaching-learning context.

In this sense the present research can be divided in two sub-studies (Figure 1) rooted in the following research questions:

Question I: Can we identify any difference in each teacher’s PTA and TQP over time, when they teach at undergraduate level, by observing them in two distinct academic years?

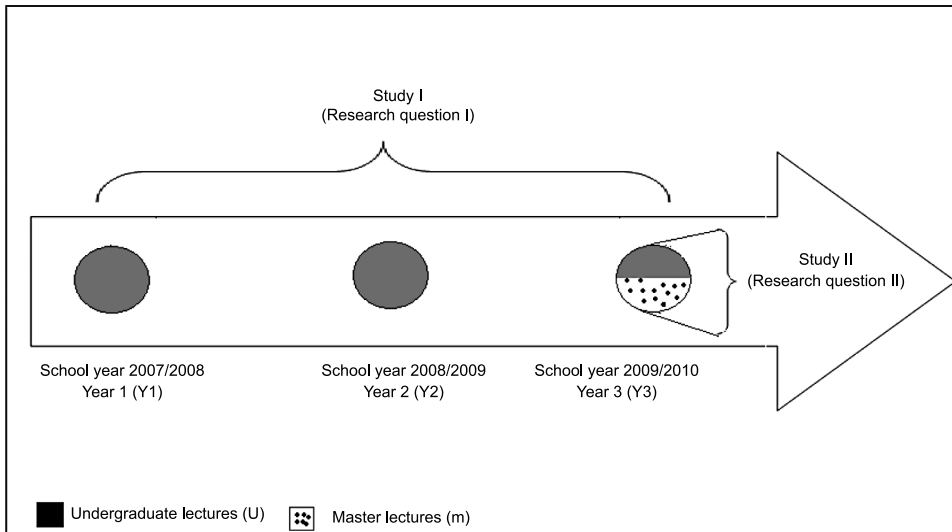


Figure 1. Schematization of the global research strategy.

Question II: Do teachers, when working at masters level, reveal PTA and TQP distinct from what is adopted in their undergraduate classes?

Methodology

For the present investigation empirical evidence was gathered by observing all professors lecturing undergraduate and masters students during 2009/2010 (Year 3). The researcher acted as a non-participant observer (Tuckman 1999), annotating relevant teacher and student behaviours in an observation grid designed for the present research project (Pedrosa-de-Jesus and da Silva Lopes 2009). At the beginning of each observation the teacher introduced the researcher to the class, explaining that the aim was to ‘study how the teacher and the students interacted during lectures’ and asked permission to audio-tape the discourse. All students agreed.

Four undergraduate (U1, U2, U3 and U4) and two masters (m1 and m2) lectures were observed for each teacher. Lectures lasted two hours and were attended by nearly 40 students. It is important to emphasise that the majority of courses in the Biology Department are organised in modules, reducing, consequently, the number of observable lectures for each professor, particularly at masters level.

For further discourse analysis, the audiotapes of half of the observed lessons, for each context, were fully transcribed (U3, U4 and m2). Teacher–student interaction episodes were identified within each transcript and analysed considering the TQP, integrating: (1) frequency of teacher questions; (2) the way teachers deal with the absence of a solicited student answer; and (3) the nature of teachers’ reaction to a student intervention (question or answer).

For the identification of the global teaching ‘mode’ of each teacher, we adopted again Trigwell and co-workers’ concept of PTA and the corresponding inventory. The main reasons were: first, previous findings revealed that the inventory is a reliable and valid instrument (Pedrosa-deJesus, da Silva Lopes, and Watts 2008); second, the inventory is directed specifically to university teachers; and third, the inventory is

short and concise, making it accessible to busy university teachers. All teachers completed two samples of the Portuguese version of the ATI-R, after lecturing their module (one for the undergraduate lectures and the other for masters lectures). To complement the PTA characterisation of each teacher and explore their perspectives about the teaching-learning processes, particularly their questioning, all teachers were also interviewed (semi-structured interviews) at the end of the academic year. All interviews were audio-taped and had a mean duration of 40 minutes. Transcripts of the four interviews were subjected to content analysis (Cohen, Manion, and Morrison 2003; Tuckman 1999) using the software NVivo7.

Results and discussion

In this section, the relationship between PTA, identified through the application of the inventory, and TQP, identified through lecture discourse analysis, will be discussed. Notes from lecture observations and data from interviews will be used to complement and sustain the characterisation of the relationship between these two dimensions. The main focus will be the comparison between teachers identified as having opposite PTA (ITTF teachers vs. CCSF teachers). However, characterisation at the individual case level will also emerge whenever considered relevant.

Study I – changes of PTA and TQP along the three years of collaboration within undergraduates

According to the inventory results (Table 5), the four professors maintained their PTA identified at the beginning of the research project (Table 1). Anna and Beatrice were identified as being more ITTF, and Charles and David as CCSF teachers.

Lecture observation and interview data corroborate these findings. The teaching and learning conceptions of the professors remain basically the same for each teacher 'type'. Beatrice, like her colleague Anna, tended to focus on the importance of the content that the teacher has to transmit, and the students have to learn, in order to accomplish external demands, such as passing the final examination. This type of teaching/learning conception, strongly focused on the teacher and in the syllabus or textbook (Trigwell 2001), is present in Beatrice's following statement:

For me, teaching microbiology is trying to motivate the students for something *I like*. *I like* Microbiology very much. That's the first thing. Second, and considering lectures, I use power point *to guide myself* ... to avoid getting lost ... Sometimes, *when I start to talk* about something that *I like I can't stop* ... I can talk about it during the entire lecture,

Table 5. ATI results of the four professors (Year 3).

Context	PTA poles	Professors			
		Anna	Beatrice	Charles	David
Undergraduate	ITTF	4.0	4.2	2.7	3.0
	CCSF	3.9	3.4	3.8	4.0
Masters	ITTF	4.0	4.2	1.5	3.0
	CCSF	4.0	3.4	4.8	3.7

Note: Results based on the mean numeric response for each pole.

but that is not the purpose ... The aim is to *teach them* [students] some *basic concepts* that they *have to learn* in microbiology.

In contrast, both CCSF teachers tend to focus on the importance of the personal development of the students, taking into account the knowledge they may bring to the process of ‘changing conceptions or world views’ (Trigwell 2001). During the interview David said:

For me, this discipline [evolution] should be a space of discussion of a theme that I, as a biologist, consider fundamental (...) Discussing evolution with the students in order to ... *make them understand* all the concepts and mechanism of evolution and the final result ... *all this biodiversity* ... For me the discipline would be perfect if I could discuss all these things with my students setting out there in the grass. For me teaching is much more than explaining concepts and mechanisms. (...) [It is] *helping students to deal with their knowledge* (...) *to make them use and expand that knowledge* by discussing it with me *and particularly discussing it with their peers*.

Relating the two ‘types’ of teaching conceptions, and the corresponding PTA, with the observed TQP during undergraduate lectures, it is possible to perceive that the relationship between these two dimensions, identified during the first year of collaboration, is maintained. ITTF teachers used self-answers nearly 40% of the time, while both CCSF teachers clearly ‘avoid’ self-answering their own questions, doing this less than 5% of the time (Table 6). Indeed, CCSF teachers ‘make time in “formal teaching time” for students to interact and to discuss the problems they encounter’ (Trigwell

Table 6. Undergraduates’ and teacher behaviour after a teacher question (Year 3).

Professor	Lecture	Teacher question	Student answer	Teacher reinitiation effort	Teacher self-answer
Anna	F_{U3}	80	26	20	34
	F_{U4}	72	30	21	21
	M	76	28	20	28
	$\%_{u3+u4}$	100	37	27	37
Beatrice	F_{U3}	52	4	28	20
	F_{U4}	22	9	5	8
	M	37	7	16	14
	$\%_{u3+u4}$	100	18	45	38
Charles	F_{U3}	67	43	20	4
	F_{U4}	72	36	35	1
	M	70	40	28	2
	$\%_{u3+u4}$	100	57	40	4
David	F_{U3}	49	37	10	2
	F_{U4}	40	25	14	1
	M	45	31	12	2
	$\%_{u3+u4}$	100	70	27	3

F , frequency; M , mean of U3 and U4.

2001, 67). Charles' conscientious effort in resisting to 'fill in' the student silence with a teacher answer became evident during the interview:

I try to be the last person to comment on something that is said during the lecture. Because, when I say something, the discussion between the students tend to stop immediately ... it's like they [the students] think: 'OK, the teacher has spoken'. What he says is the 'holy truth'. No student dares to question what the teacher says. I dislike that.

The lower number of teacher self-answers of both CCSF teachers seems to be related to higher percentages of student participation, over 57% of the teacher's question obtained an answer. Beatrice (ITTF) obtained the lowest number of student responses, only 18% of her questions were answered (Table 6).

Similar to the first year of undergraduate lecture observation, no clear relationship between the frequency of teacher questions and the two types of PTA was identified during Year 3. The four professors asked significantly more questions than their undergraduates. However, comparing students' questions frequency with teachers having opposite PTA, it was realised that a CCSF approach seems to have a positive impact on students' learning behaviour: undergraduates asked a mean of 10 questions per lecture with CCSF teachers, while only a mean of three questions per lecture was obtained with ITTF teachers. Besides the higher frequency of students' questions, it was also possible to observe that the interaction between students and CCSF teachers was longer, implying several sequential utterances and not only single words (such as 'yes' or 'no') commonly used by students during lectures of both ITTF teachers (Pedrosa-de-Jesus and da Silva Lopes 2009).

Considering the low frequency of students' questions, it was not possible to identify any pattern of teachers' reaction to students' questions. However, taking into account CCSF teachers' higher frequency of dialogic reaction to students' responses, and also the higher interactivity with students during lectures of these teachers, it is believed that the dialogic nature of teachers' reaction can be considered as another example of Gunel's (2008) complementary pedagogic behaviour, enhancing quality learning. Therefore, we consider that 'quality questioning' also involves dialogic reactions to student intervention and minimum teacher self-responses.

Interview data also identified that different TQP affects students' motivation. The majority of students stated their preferences for CCSF teachers' lectures. However, some students acknowledged feeling more comfortable with teachers who were identified as having an ITTF approach, despite interacting more often with the opposite 'type' of teacher. The issue of (mis)match between teaching approaches and students' learning preferences, particularly their perception of different 'questioning zones' is relevant to this context and is discussed in our previous work in this area (Pedrosa-de-Jesus et al. forthcoming).

Focusing on the TQP of each teacher individually, and comparing the findings obtained during Year 1 with those obtained during Year 3, it is Beatrice who stands out. She considerably increased the number of formulated questions, passing from an average of 22 questions per lecture (Table 3) to an average of 37 questions per lecture (Table 6). In fact, during the interview she mentioned some type of 'modification' considering her TQP along the three years:

I don't know if you agree with me. But now I feel that I try to interact much more with the students. I try to ask more questions. *Questions are useful to maintain them more concentrated and focused. It helps me to monitor their learning. If they don't know, I say 'well, you haven't study until now'.*

During the interview, Beatrice revealed that she was aware of the changes in her questioning. Indeed Beatrice’s ‘modification’ resulted in the formulation of 52 questions during lecture U3, which is, in her own words: ‘a very high frequency for me! ... I think this is very positive, probably resulting from the involvement in this project’.

However, during the interview she also revealed that her teaching purpose remains, ‘checking relevant knowledge acquisition’ by students, using questions as a tool for that purpose. Beatrice’s ‘form’ (frequency) of questioning changed, but not its functionality. Indeed, the higher number of teacher’s questions (Table 6) is mainly due to an increase of Beatrice’s reinitiation effort when facing the absence of a solicited students’ answer (Figures 2a and 2b). The key issue here is that the increase of reinitiation efforts was also accompanied by an increase of self-answers, which passed from 21% to 38% (Figures 2a and 2b), indicating that ‘real’ teacher–student interaction actually did not increase. Beatrice only increased *her* questions and *her*

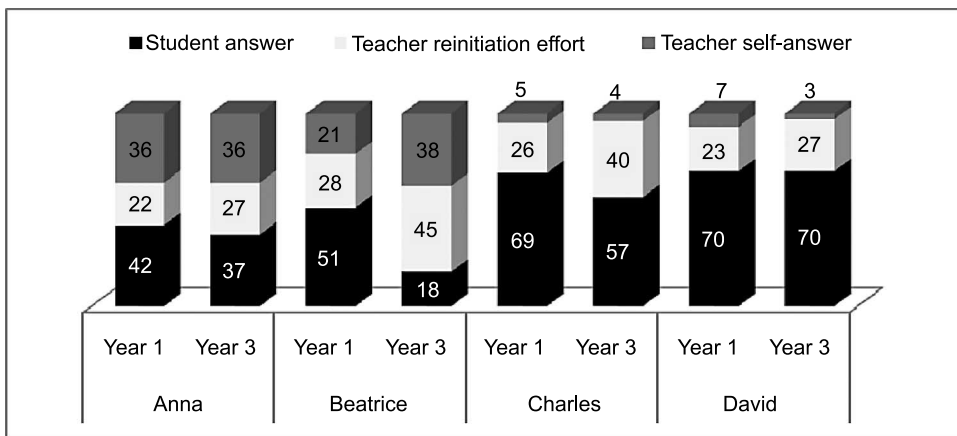


Figure 2(a). Undergraduates and Teachers’ behaviour after a Teacher question (Year 1 vs. Year 3). Note: Percentages calculation based on the number of teacher questions during Year 3, Table 7.

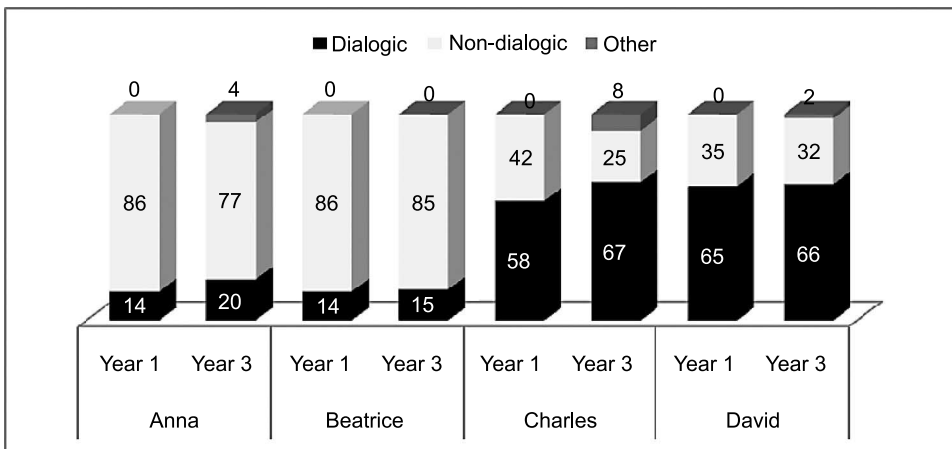


Figure 2(b). Teachers’ behaviour to undergraduates’ answers (Year 1 vs. Year 3). Note: Percentages calculation based on the number of teacher questions during Year 3, Table 7.

(self-)answers. The decrease of obtained student answers to 18% reinforces this interpretation (Figures 2a and 2b). Combining this quantitative perspective with a more qualitative approach, and taking, as an example, the interaction episode illustrated in Table 7, it might be concluded that ‘eager’ questioning can result in conflict with the purpose of engaging with students reasoning. Therefore, a higher frequency of teacher questions may not result in an increase in students’ interventions. These results reveal how difficult it can be to effectively manage what to do in order to maximise students’ participation (Gunel 2008).

Looking at Charles’ questions frequency, an average of 87 questions per lecture during the first year (Table 3) and 70 questions during Year 3 (Table 6), it seems that there is a slight decrease in the enquiry moments. However, this under-representative mean is a consequence of the untypical U3 lecture. Quoting Charles: ‘Students were more concerned about the exam they were going to have after the class [in another subject], than with the microbiology lecture itself. The result was an unpleasant and boring lecture’. Discourse analysis of the remaining observed lectures (U1 and U2) might minimise the ‘entropy’ effect of these ‘external factors’.

Considering the way teachers dealt with undergraduates’ answers over the three years of collaboration (Figure 3), some increase in dialogic reactions with all of them was noticed. Responding to students’ answers, Anna moved from 14% to 20%, a percentage that remains considerably under the percentage of her two CCSF colleagues, namely over 58%. Beatrice’s non-dialogic reaction to students’ answers remained very high, since dialogic reactions increased only 1%. These findings reinforce, again, the fact that the changes in Beatrice’s questioning practices are more

Table 7. A teacher–student interaction from Beatrice.

Teacher (T)–student (S) dialogue	TQP
T: Last lecture we spoke about gene multiplication in prokaryotes, and we talked about two different mechanisms of gene expressions. Which mechanisms were they? S: Lactose and tryptophan.	Initiation effort
T: Ok. The operon of lactose and the operon of tryptophan. These two mechanisms of gene regulation, are they similar? S: x (no answer)	Dialogic reaction to a student answer
T: Are they similar? S: x	Reinitiation effort (=)
T: Don’t worry me! Which is the difference between the mechanisms? S: x	Reinitiation effort (=)
T: In the lactose mechanism gene expression is regulated by three ways which are? S: x	Reinitiation effort (▼)
T: In the lactose mechanism gene expression is regulated by three ways, which are positive regulation, negative regulation and ... S: Catabolite regulation.	Reinitiation effort (▼)
T: Yes. And the tryptophan is regulated by inhibition.	Non-dialogic reaction to student answer

Note: at the observation grid for this episode: the teacher does not give the students time to think and reflect. They are ‘bombed’ with a teacher question.

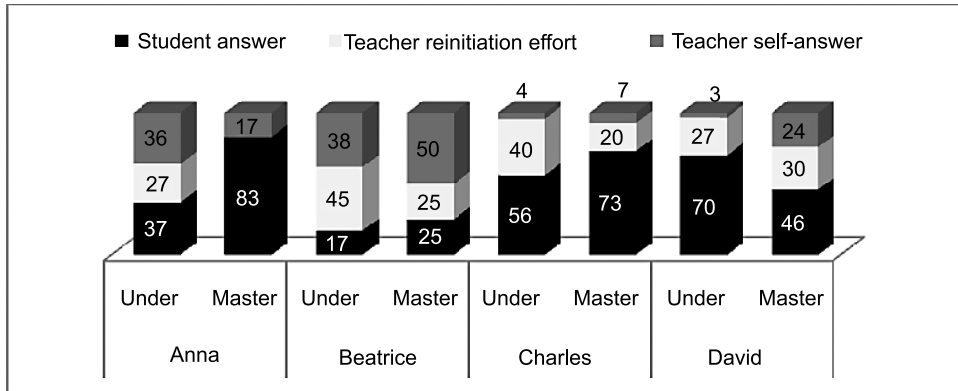


Figure 3. Students’ (under vs. masters) and teacher behaviour after a teacher question (Year 3). Note: Percentage calculation based on the number of teacher questions, Table 7.

quantitative than qualitative, since the majority of her reactions to students’ interventions do not stimulate their intellect, being of non-dialogic nature.

Study II – influence of the contextual factor ‘student development’ (undergraduates vs. master) on teachers’ PTA and TQP

Results from the Portuguese version of ATI-R demonstrated that Beatrice, Charles and David maintained their PTA within the context of masters lectures (Table 5). Anna, however, did not show a clear tendency for one ‘pole’, CCSF or ITTF. This result might be better understood by her dilemma expressed after considering the inventory:

I must say that it was very difficult to me to fill in the inventory for the masters students. I was confused about what I actually do ... and what I should do. I think I mixed it up very often. I couldn’t decide.

This type of dissonance, probably rooted in a strong desire to develop a learner-focused teaching approach, is also reported in Postareff et al.’s research (2008).

Since the inventory results remain similar for undergraduate (Year 1 and Year 3) and masters disciplines (Year 3), it might be concluded that the professors’ teaching and learning conceptions are the same in these two distinct contexts, considering students’ development: ITTF teachers focus on content transmission, while CCSF teachers focus on ‘conceptual change or development’. Lecture observations and interview data indicate that ITTF teachers have an even stronger focus on information acquisition. Anna and Beatrice stated that ‘masters’ lectures are not really places for ‘explaining’, because students are much more developed. They know how to learn. Lectures are just for ‘contextualising’ their learning and to indicate which themes have to be studied. For instance, Beatrice stated during the interview:

I really don’t know why we have to give these lectures. I easily could post on the e-learning platform a list of the main references for them to study. And, if they have doubts they could arrange a meeting with me.

On the other hand, CCSF teachers did not emphasise the fact that students are more mature, therefore more able and knowledgeable. Both teachers stressed that lectures should be places for discussing and learning *with* students, and that masters students (unfortunately) demand ‘only’ the delivery of ‘text book information’, seeing this as very important to their learning. For example, during the interview Charles stated:

They [masters students] dislike discussing ideas. The students don’t realise that they can learn a lot by ‘talking to each other’ and share their experience, their expertise. For the majority of these students ‘learning is receiving a lot of information’. It is very difficult to fight this tendency.

Focusing on the relationship between PTA and TQP, it was observed that the patterns identified with undergraduates (in both academic years), namely higher self-answers of ITTF teachers, were not maintained when lecturing masters students. For instance, within the masters context, David (CCSF) self-responded to his own questions more often (24%) than Anna (ITTF), who used self-answers 17% of the time (Table 8). However, these percentages have to be considered with much caution since data reported here were obtained from just *one* transcribed masters lecture.

On what concerns teachers’ reaction to students’ answers (Table 9), the pattern of ‘more dialogic reaction’ by CCSF teachers, than ITTF teachers, was also not clear. Anna managed to engage intellectually with 60% of the obtained students’ answers, more often than her colleagues Charles and David, 36% and 47%, respectively. However, again these results have to be considered carefully, due to the high frequency differences of obtained students’ answers between ITTF teachers (under five answers) and CCSF teachers (over 17 answers).

Table 8. Students’ and teacher behaviour after a teacher question (Year 3).

Professor	Lectures	Teacher question	Student answer	Teacher reinitiation effort	Teacher self-answer
Anna	Under	76	28	21	27
	%	100	37	27	36
	Masters	6	5	0	1
	%	100	83	0	17
Beatrice	Under	37	7	16	14
	%	100	17	45	38
	Masters	8	2	2	4
	%	100	25	25	50
Charles	Under	70	39	28	3
	%	100	56	40	4
	Masters	30	22	6	2
	%	100	73	20	7
David	Under	45	31	12	2
	%	100	70	27	3
	Masters	37	17	11	9
	%	100	46	30	24

Note: Under = mean of U3 + U4; Master = frequency of m2.

Table 9. Teachers' reaction to students' intervention (Year 3).

Professor	Lecture	Student answer	Teacher reaction			Student question	Teacher reaction		
			Dialogic	Non-dialogic	Other		Dialogic	Non-dialogic	Other
Anna	Under	28	5.5	21.5	1	4	2.5	1.5	0
	%	100	20	77	4	100	63	38	0
	Masters	5	3	2	0	0	0	0	0
	%	100	60	40	0	0	0	0	0
Beatrice	Under	6.5	1	5.5	0	9	2.5	6.5	0
	%	100	15	85	0	100	27	72	0
	Masters	2	0	1	1	1	0	1	0
	%	100	0	50	50	100	0	100	0
Charles	Under	39.5	26.5	10	3	14.5	11	3	0.5
	%	100	67	25	8	100	76	21	3
	Masters	22	8	14	0	7	3	4	0
	%	100	36	64	0	100	43	57	0
David	Under	31	20.5	10	0.5	12.5	7	4.5	1
	%	100	67	32	2	100	56	36	8
	Masters	17	8	9	0	5	2	3	0
	%	100	47	53	0	100	40	60	0

Note: Under = mean of U3 + U4; master = frequency of m2.

Of note, is that during both of the lectures of the ITTF teachers there were no interaction moments initiated by a student question. So, there was no opportunity to see how Anna and Beatrice 'dealt' with students' questions. During Charles and David's masters classes some students raised questions (five and seven, respectively), and half of them were treated in a dialogic way.

Comparing the adopted TQP while lecturing masters to the TQP adopted with undergraduates, it is possible to identify some influence of the students' maturity on the professors' way of questioning. For instance, in all four cases, but particularly with Anna and Beatrice, the number of teachers' questions tends to be considerably lower in masters lectures (Table 8). The perspective that 'interaction moments with students' tend to be more associated with undergraduates than with masters is also reinforced by the decrease of the percentage of dialogic reaction to students' answers (Table 9) and the increase of teacher self-answers during masters lectures (see Beatrice, Charles and David, Figure 3). However, considering Charles previously discussed interview statement, namely 'that masters' students don't like to discuss' and that 'it is very difficult to fight the students' pressure of delivering just information' it could be possible that both CCSF teachers have been 'forced to change' their questioning behaviour, reducing interactions with students. While both ITTF teachers focused even more on knowledge transmission, which was aligned with their teaching intentions/conceptions, it seems that CCSF teachers' concerns and questioning practices reflected a compromise between their teaching intentions and contextual features, such as masters demands. Prosser and Trigwell (1999) and Trigwell and Prosser (1996) also described approaches to teaching that were less learner-focused and more

teacher-focused than would have been expected from the inventory reported conceptions of teaching. Dissonance phenomena, that is, an atypical combination of approaches to teaching and conceptions of teaching are also discussed by Murray and McDonald (1997), Norton et al. (2005), Postareff et al. (2008) and Samuelowicz and Bain (1992). For future, interviews we are already planning to tackle the impact of this external factor on the Professors' ways of teaching, particularly questioning.

Final comments

The main purpose of this study was to deepen our understandings of the nature of the relationship between PTA and TQP. Findings from previous research have demonstrated a relationship between PTA and TQP in the context of undergraduate lectures: ITTF teachers tend to have higher self-answers and less dialogic attitudes than CCSF teachers. They also tend to have less success in obtaining students' answer (Pedrosa-de-Jesus and da Silva Lopes 2009). Taking these results into account, a research strategy was designed in order to verify if the same relationship was maintained after three years of collaboration, in the context of either undergraduate lectures (study I) or masters students (study II). In order to validate the outcomes, data from lecture observation, interviews and lecture discourse transcripts were triangulated.

The findings of study I indicate that each teacher maintained his teaching and learning conceptions, and the corresponding PTA, within undergraduate lectures, during the three years of collaboration. Looking at TQP, it was possible to identify slightly changes in some questioning practices, such as small increases in dialogic reactions to students' answers, with all four teachers. This group of teachers strongly valued their participation in the project, since it gave them the opportunity to reflect and to diversify their teaching strategies. Beatrice explicitly recognised the change in her TQP, demonstrating a considerable increase in the number of questions she raised. Despite these slightly modifications in TQP, the previous identified relationship patterns between TQP and PTA, namely higher self-answers and less frequent dialogic reactions with ITTF teachers, were maintained. The key issue illustrated by this evidence is that TQP modifications do not necessarily imply a PTA change. In this sense, research findings may indicate that Trigwell and co-workers' concept of PTA is close to Vermunt's (1998) concept of 'orientation' and to Meyer's (2000) concept of 'orchestration', since the teaching approaches identified in this study revealed to be constant across contexts.

Study II, considered whether the relationship pattern between PTA and TQP identified within the undergraduate context, was maintained within masters teaching. However, the limited number of masters lectures observed did not enable a clear answer to this question to be obtained. All professors maintained their PTA. Anna and Beatrice, both ITTF teachers, revealed during the interview that they tended to focus even more on information transmission with masters than with undergraduate students, since both considered that students were more 'autonomous', being able to learn (this is acquiring information) on their own. Therefore, teachers' main intention was focused on indicating the sources of the information that should be acquired by masters.

Considering TQP, some differences were also observed. For example, all teachers asked less questions to masters than to undergraduate's students, particularly ITTF teachers. The relationship pattern between PTA and TQP identified in the undergraduate context could not be confirmed in masters classes. The reasons could be the

reduced number of observed masters lectures and the influence of external ‘factors’ resulting in dissonances between teaching conceptions and approaches (Postareff et al. 2008). Indeed, interview data indicate that the modification of the questioning practices of CCSF teachers seems to be more a result of an ‘unwanted’ adaptation to the students’ demands. Again, masters lecture findings suggest that (small) changes in TQP do not necessarily imply the modification of the teachers’ PTA, indicating that ‘teaching approaches’ are relatively constant across contexts.

In conclusion, four major outcomes of this research should be re-emphasised:

- (1) Even when lecturing similar disciplines, different teachers teach in different ways (Norton et al. 2005). Despite a certain ambiguity in the notion of ‘approaches to teaching’ (Norton et al. 2005; Osterheert and Vermunt 2001), teachers identified as having opposite PTAs used questioning in distinct ways, influencing students’ questioning behaviour.
- (2) Both studies indicate the existence of a strong internal relationship between teaching conceptions and the adopted teaching practices, namely questioning, reinforcing the outcomes of other investigations which conceptualise ‘teaching in action’ and ‘theories of teaching’ as complementary phenomena (Martin et al. 2003; Postareff et al. 2008). Therefore, we believe that TQP can be a useful indicator of the main teaching and learning conceptions of a teacher. This is, if we observe a teacher frequently self-answering his own questions and having difficulties in engaging, in a dialogic way, with students’ reasoning, it might be hypothesised that the teacher probably has an ITTF approach, and therefore conceives teaching as being the transmission of information and learning as the acquisition of that information.
- (3) Disjunction between conceptions and practices was only identified with CCSF teachers. Taking into account evidence from other studies, it seems that atypical combinations of conceptions and behaviours reflect a compromise between intentions/conceptions of teaching and academic/social context (Stark 2000; Trigwell, Prosser, and Waterhouse 1999). Therefore, the consideration of contextual variables influencing the teaching practices might explain why the four teachers changed their TQP between masters and undergraduate lectures. Integration of the ‘perception of teaching environment inventory’ (Prosser and Trigwell 1997) in further research might be useful in the understanding of this phenomenon.
- (4) During the three-year project in an undergraduate context, and one year in the masters context, changes in TQP were observed, while the PTA was maintained, indicating that it is more difficult to change ‘teaching’ and ‘learning’ conceptions than ‘teaching practices’. Focusing on masters lectures, modification on TQP seemed to be driven essentially by external factors of the teaching environment and the teachers’ perception of those factors (Trigwell, Prosser and Waterhouse 1999). Therefore, and recapturing Devlin’s (2006) interrogation, it seems that teaching conceptions drive internally teaching practices, such as questioning. However, external factors may induce a change in teachers’ behaviour (questioning) without implying a modification in their teaching and learning conceptions. In this sense, and inspired by Curry’s Onion Model for Learning Styles (1987), our argument is that teaching and learning conceptions, as the core or inner layer of the teacher’s ‘being’, are likely to be more resistant to change than behaviours (Figure 4).

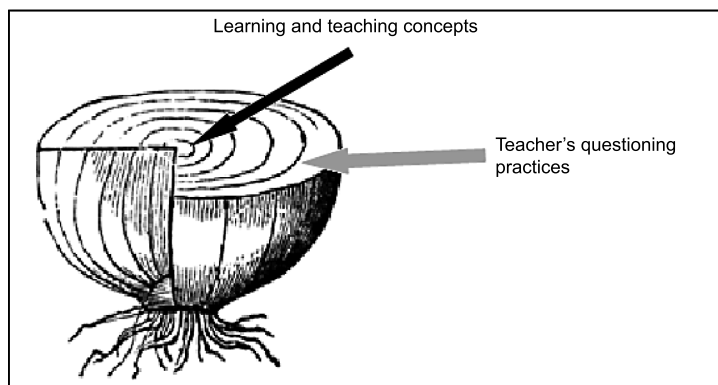


Figure 4. PTA: University teachers' conceptions and practices – a possible relationship. Note: Image adapted from, Gray, Asa. *The Elements of Botany for Beginners and for Schools*. New York: The American Book Company, 1887. 'Live oak leaves'. http://etc.usf.edu/clipart/plants/live_oak_1.htm (accessed May 3, 2010). Copyright: 2011, Florida Center for Instructional Technology.

The majority of studies claim that genuine development will come only by addressing teachers' underlying and relatively entrenched teaching and learning conceptions (Entwistle and Walker 2000; Kember and Kwan 2000; Trigwell and Prosser 1996), which also have implications for teachers' behaviours and consequence in relation to the quality of students' learning (Norton et al. 2005; Osterheert and Vermunt 2001; Vermunt 1998). However, considering research evidence, our perspective is that changes in TQP might be a step *towards* the changing of teaching and learning conceptions. That is, we believe that the changing of some teacher (questioning) practices, and the realisation of the impact of those changes on students' learning, might be a powerful instrument towards the beginning of a process of changing the teachers' conceptions, similar to what Osterheert and Vermunt (2001) call the 'domino effect': changing the perception of a relatively tiny bit of classroom reality may generate many more changes in ones 'being a teacher'.

Combining these outcomes, and considering that they are the results of a three-year collaboration, we believe that *significant* and *long-lasting* positive change in higher education asks for *hard* and *continuing* work *with* and particularly *between* university teachers (Marshall and Drummond 2006; McAlpine and Weston 2000; Postareff, Lindblom-Ylänne, and Nevgi 2008; Trigwell 2001; Trigwell, Prosser, and Waterhouse 1999; Veiga and Amaral 2009). With this in mind, we present the following suggestions for the design of continuing professional development (CPD) strategies:

- (1) Peer lecture observation and peer teaching between 'ITTF' and 'CCSF' teachers, followed by discussion moments and debate, could be one way of promoting student-centred approaches among university teachers. Indeed, our findings led us to believe that collaborative work *between* university teachers might be one of the missing pieces towards more student-centred universities, since CCSF teachers retained teaching and learning conceptions closer to the perspective of student development and high-quality learning (Marshall and Drummond 2006; Martin et al. 2003; Trigwell 2001). Furthermore, CCSF

teachers were identified as interacting globally ‘more’ and ‘better’ with students, in this context this meant more frequently in a dialogic way (quality questioning).

- (2) Even CCSF teachers need some teacher training since the disjunction identified in CCSF teachers might be rooted in the fact that they have not obtained sufficient training in staff development to enable them to operationalise their conceptions of teaching in appropriate teaching strategies according, or ‘despite’, the demands and constraints of the academic context in which teachers are required to work (Murray and Macdonald 1997; Norton et al. 2005; Prosser and Trigwell 1999).

Finally, we would also like to emphasise the importance of moderating students’ conceptions of what good teaching is. They too need to be inducted into new teaching and learning approaches, in particular questioning, and most importantly need to see the value of such a change in approach and value this as a form of learning.

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