Different Orientations to Teaching Science and its Relation to the Discursive Interactions

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ABSTRACT

One of the most important models for the Pedagogical Content Knowledge (PCK), proposed by Magnusson and collaborators, has the "Orientation to Teaching Science" (OTS) on the top of the model. Such model has recently received several critiques due to its lack of empirical corroboration. To solve those issues, Wongsopawiro developed a new approach to them. This paper aims to explore the correlation between these two ways to classify the OTS and its relation to the Discursive Interaction. Through a mixed model approach, a case study was developed with a chemistry pre-service teacher who had his class recorded and coded. The correlation between the codes was verified and showed that Wongsopawiro's and Magnusson's orientations possess strong interconnections. Finally, it was possible to establish a relation between Discursive interaction and Goals & Intended Strategies, being the Interactive/Authoritative Approach present above all others.

Keywords: Discursive Interactions. Mixed Model. Orientations to Teaching Science.

Diferentes Orientações para o Ensino de Ciências e sua Relação com as Interações Discursivas

RESUMO

Um dos mais importantes modelos de Conhecimento Pedagógico do Conteúdo (PCK, da sigla em inglês), proposto por Magnusson e colaboradores, tem as "Orientações para o Ensino de Ciências" (OTS, da sigla em inglês) no topo do modelo. Tal modelo tem, recentemente, recebido diversas críticas devido à falta de corroboração empírica. Buscando solucionar tal questão, Wongsopawiro desenvolveu uma nova abordagem para as OTS. Este artigo tem o objetivo

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Recebido para publicação em 28 fev. 2018. Aceito, após revisão, em 26 abr. 2018.

de explorar a correlação entre estes dois modos de classificar as OTS, e suas relações com as Interações Discursivas. Por meio de uma abordagem de métodos mistos, um estudo de caso foi desenvolvido com licenciandos em química, os quais tiveram suas aulas gravadas e codificadas. A relação entre os códigos foi verificada e mostrou que a classificação de Wongsopawiro possui fortes interconexões com as de Magnusson. Finalmente, foi possível estabelecer uma relação entre as Interações Discursivas e os Objetivos e Estratégias de Wongsopawiro.

Palavras-chave: Interações Discursivas. Métodos Mistos. Orientações para o Ensino de Ciências.

INTRODUCTION

One of the seminal researches on teacher professionalisation was made by Lee Shulman (1986) whose papers defended the existence of a Knowledge Base for Teaching, including the Pedagogical Knowledge and the Pedagogical Content Knowledge (PCK). Since then, several researchers tried to grasp the true nature of the PCK (e.g. Grossman, 1990; Magnusson, Krajcik, & Borko, 1999; Rollnick, Bennett, Rhemtula, Dharsey, & Ndlovu, 2008). One PCK component that plays an important role in the planning and conducting of classroom teaching (Talanquer, Novodvorsky, & Tomanek, 2010) is the "Orientations to Teaching", being popularised by Magnusson's et al. (1999) model. It was defined as "teachers' knowledge and beliefs about the purposes and goals for teaching science at a particular grade level" (Magnusson et al., 1999, p.97), having, in this model, a "pivotal position" (Friedrichsen & Dana, 2005, p.219) as it shapes (and is shaped by) all other knowledge and serves as a "conceptual map that guides instructional decisions about issues such as daily objectives" (Magnusson et al., 1999, p.97).

The Orientations to Teaching Science (OTS) have different denominations (e.g. Conceptions of Teaching, Preconceptions of Teaching, Belief, Image and Metaphor) (Abell, 2008; Koballa, M., & Upson, 2005), and are present in various works (Kember & Gow, 1994; Pratt, 1992; Talanquer et al., 2010). Originally conceived in Shulman's work, they are presented as "knowledge of educational ends, purposes, and values, and their philosophical and historical grounds" (1987, p.8). On the other hand, the Consensus Model of PCK presented OTS as a Filter and Amplifier, not as a component of the PCK (Gess-Newsome & Carlson, 2013, 2014).

Despite its broad use, this model has received some critics. First, in Magnusson's et al. (1999) definition, orientation is the association of two different conceptions about this construct, the one proposed by Grossman, "conceptions of purposes for teaching subject matter" (1999, p.99) and the one made by Anderson and Smith which focus on teacher behaviour (as cited in Friedrichsen, van Driel, & Abell, 2010). To do such amalgamation, no reason or explanation is given, and that is reflected in the components of this knowledge. They can be divided mainly into two groups (Friedrichsen & Dana, 2002): (A) centred in the curriculum and curricular reforms, from the 60s (process, activity-driven, discovery), and contemporary (conceptual change, project-based science, inquiry, and guided inquiry), and (B) centred in the teacher (didactic & academic rigor), each relating respectively to the two definitions referred above. Second, the orientations come from different sources and lack of theoretical and empirical ground (Friedrichsen et al., 2010), being the only empirical studies done with a few elementary teachers, under-representing middle and secondary teachers.

This orientation list, with this lack of definition and different uses of the construct, has lead researchers to assign “science teachers to one of the nine orientations”, in a grasp for a “quick fix to the thorny problem of characterizing teachers’ complex beliefs systems” (Friedrichsen et al., 2010, p.368). By doing so, they ignore even Magnusson’s premise that teachers can hold multiple orientations. One important discovery in this line, is that pre-service teachers (PSTE), and even inexperienced teachers, do not have a specific orientation, but instead they hold a more “generalised orientation to teaching that guides their instructional decision-making process for teaching” (Friedrichsen & Dana, 2005, p.220) with two or more orientations. That also agrees with Koballa’s et al. (2005) argument that novice teachers hold two different orientations, one ideal, and one working conceptions of teaching science.

To resolve part of those issues, other compositions were made. Wongsopawiro (2012), investigated how the goals and purposes of teaching related to the instructions the teachers intended to use in their plans; using this strategy, he came up empirically to his classification of the Orientations. The results have shown the existence of four different *Purposes and Goals* (content, skills, inquiry, and motivation) and four *Intended Strategies* (lecture, hands-on, experiments, and projects). This work is very important once it is congruent to both Magnusson’s et al. (1999) model, as the definition of his orientation encompasses teacher’s behaviour and curricular goals, and Friedrechsen and Dana’s (2002) critics as he divides them into two different categories. In this sense, Wongsopawiro was able to align two important researchers in the PCK field in an empirical and substantial research.

Despite his work, there is still a gap in the field of studies aiming to understand teachers’ orientations. Discursive interaction is one important aspect related to teachers’ actions (Scott, Mortimer, & Aguiar Junior, 2006) that is not much researched in relation to the PCK. Such referential, originally proposed by Mortimer and Scott (2002), is grounded in the Bakhtinian discursive analysis and offers a framework for understanding the way teachers interact with their students.

The analytical framework proposed by those authors is based on five interrelated aspects, which focus on the teacher’s role in making scientific history available on the social level of classroom and support the students in the process of sense construction of this history. These five aspects are grouped into three teaching dimensions, as can be seen in Table 1:

Table 1. *Analytical framework development* by Mortimer and Scott (2002).

Aspect of Analysis		
I. Focus	1. Teaching purposes	2. Content
II. Approach	3. Communicative approach	
III. Action	4. Patterns of interaction	5. Teacher interventions

The first teaching dimension is the *focus*, which is related to the teacher's intentions and organisation of content. The first aspect of the analytical framework, *teaching purposes*, is designed to answer what are the intentions of the teacher in a specific phase of teaching sequence with regard to the development of scientific content (Aguiar Junior & Mortimer, 2005).

The second aspect of analysis, *content*, does not aim to evaluate the content itself, but how it is organised. In general, these dimensions are intended to analyse what is the nature of the knowledge elaborated by teacher and students during certain stages of the educational process (Aguiar Junior & Mortimer, 2005).

The second dimension of teaching is the *approach*, which involves the communicative approach that the teacher uses in his teaching sequence. This third aspect of the analytical framework is central since it is the link between first and third dimensions. Communicative approaches provide insight on how the teacher works its intentions and content of teaching by different interventions, which result in different patterns of interaction.

Communicative approaches can be classified into two axes: interactive or non-interactive speech; and dialogic or authoritative speech. In summary, the communicative approach seeks to answer how the teacher works with students (or students work with each other), considering the diversity of ideas present in the classroom during a certain phase of class or class sequence (Aguiar Junior & Mortimer, 2005). The central problem seems to be the balance between a dialogic versus authoritative discourse and between an interactive versus non-interactive way (Aguiar Junior, Mortimer, & Scott, 2010; P. H. Scott et al., 2006).

The third dimension is *action*, which involves the way the teacher interacts with students, resulting in interaction patterns created by interventions used by the teacher. According to Aguiar Junior and Mortimer (2005), the key issue of the fourth aspect, *patterns of interaction*, is to identify which "patterns of interaction are established when the teacher and student alternate speech shifts in the construction of discourse in the classroom" (p.185). Among the possible patterns, the most common is the triad I-R-A, which means teacher initiation (I), student response (R) and teacher evaluation (A).

Finally, the fifth aspect of analysis, teacher intervention, refers to forms of pedagogical interventions the teacher uses to develop scientific history, making it available to the students in the classroom.

Therefore, in this work we discuss different codings of the orientations to teaching science, through an analysis of a pre-service teachers' class, trying to correlate them to a preferred discursive interaction type.

STUDY DESIGN

This study follows the critic theory paradigm, with a historic-realism ontology, a transactional epistemology and a dialogical/dialectical methodology (Guba & Lincoln, 2000). It was conducted with a mixed model approach (Johnson & Onwuegbuzie, 2004) in a case study strategy (Creswell, 2007). To minimize the inherent bias of the research (Kincheloe & McLaren, 2000; Rajendran, 2001), and to achieve trustworthiness as "an accurate reflection of reality" (Cho & Trent, 2006, p.319), it was validated by a blind researcher followed by a post-hoc discussion (MacCoun & Perlmutter, 2015). In addition, the methods and data were deposited in the Centre for Open Science's Open Science Framework to assure transparency (Nuzzo, 2015). Also, to increase trustworthiness, debriefing sessions were developed under peer scrutiny; triangulation of methods; audit trail; examination of previous research findings; prolonged engagement; and well-established and overlapping methods were used (Bowen, 2009; Carcary, 2009; Shenton, 2004). The research was part of a doctoral thesis which was approved by an ethics committee and is registered under the number CAAE (Certificado de Apresentação para Apreciação Ética) 43527815.8.0000.5594. Some results were also presented at the III National Congress for Teacher Formation (Gastaldo, Mello, Castro, & Leal, 2016).

The research was conducted in a public university of São Paulo, Brazil, in the course for chemistry teachers, in a discipline whose syllabus claims stimulating students to plan and conduct laboratory classes. It had 22 encounters and was structured in 4 moments: theoretical apprehension; experiments test in which the pre-service teacher (PSTE) tested the classes they were to teach; class ministration, when the PSTEs taught their classes; and class discussion in which the PSTEs discuss their classes with the teacher and their peers. It was held partially in a conventional class mode (with chairs in front of a chalkboard) and partially in a laboratory (the experiments testing and class ministration). The classes taken by the PSTEs had about 3 hours and the ones taught by them around 60 minutes each. The classes were attended by 10 PSTEs, being 4 men and 6 women; divided into 4 groups, and their classes had around 30 high school students. The PSTEs' ages ranged from 23 to 39 years old (an average of 24.42 ± 5.94 years), and most of them had at least 1, and up to 4, years of class experience. In this work, the data collected from one of the groups was analysed.

The data was collected by non-participant observation, video recordings, instructional material, institutional documents, teachers' lesson plans, and standardised questionnaires (Milani et al., 1983). All the classes were videotaped and coded using the software Transana®, searching for the observable indicators of the OTS (Hewson & Hewson, 1988) and the discursive interaction (Mortimer & Scott, 2002).

The validation of the codification was performed by the Cohen's Kappa analysis, expressed in equation 1, in which ρo represents the observed agreement, and ρe the random agreement (Landis & Koch, 1977).

$$\kappa = \frac{\rho o - \rho e}{1 - \rho e} \qquad \text{Eq. 1}$$

Although the Kappa (κ) magnitude value significance is arbitrary, it is useful to establish a threshold of the inter-rater reliability, which in this paper a κ above 0.80 was considered (Landis & Koch, 1977; McHugh, 2012). To confer greater value to this measure, the Confidence Interval (CI, equations 2 and 3) was calculated, wherein n represents the number of analyses, and the constant 1.96 is due to the desired CI of 95% (McHugh, 2012).

$$\kappa - 1{,}96xSE_{\kappa} < \mathrm{CI} < \kappa + 1{,}96xSE_{\kappa} \qquad \text{Eq. 2}$$

$$SE_{\kappa} = \sqrt{\frac{\rho o(1-\rho o)}{n(1-\rho e)}} \qquad \text{Eq. 3}$$

After validation, codes and moments of occurrences (first third-beginning, second third-middle, and third third-end) were quantified, being co-occurrences counted and their relevance verified by the c-index equation (Eq. 4) (Brailas, 2014; Friese, 2005, 2015).

$$\frac{f_{AB}}{(f_A + f_B) - f_{AB}} \qquad \text{Eq. 4}$$

RESULTS AND DISCUSSION

The analysis initially has shown a Kappa index of 0.82, and a standard error of 0.02, which gives 0.78 < CI < 0.86. Besides this high Kappa, the discordances are discussed as follows to reach a consensus.

As can be seen in Figure 1, the main OTS held by the PSTEs, according to Magnusson's et al. (1999) scheme, was Didactic (62,12%), which has as characteristics the presentation of "information, generally through lecture or discussion, and questions directed to students" (Magnusson et al., 1999, p.101). The second was Process (24,24%), which by its turn introduce "students to the thinking processes employed by scientists to acquire new knowledge [engaging] in activities to develop thinking process and integrated thinking skills" (Magnusson et al., 1999, p.101). Talanquer et al. (2010) have found that the most frequent orientation in their study was Motivating Students, what does not agree with the findings of this work. As they describe, such orientation focus on the use hands-on activities, which, in this work, was not done until the very end of the class and the purpose of it was to access the comprehension of the students not to motivate them. Also, the lab work was not a proposal of the PSTEs but, defined in the syllabus, being the lecturing the preferred teaching strategy, what subscribes to Prawat's (1989) proposition.

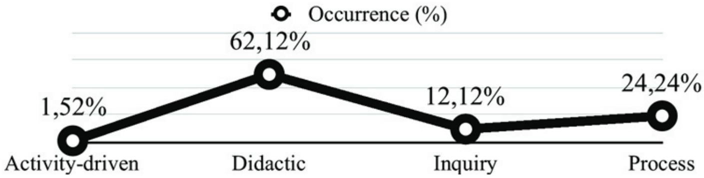

Figure 1. Occurrences of Magnusson's et al. (1999) Orientations in the analysed class.

In Talanquer's et al. (2010) work, the following most frequent orientation was Process; they argue that teachers with a Process orientation, believe that students can assimilate the content directly from experience, assuming a naïve constructivism (Prawat, 1992). This strategy can be found in the present work as the PSTEs encouraged the students to "investigate" the reason for the pH interfere in the solubility of CO_2 in water, either empirically or through reasoning.

Regarding Wongsowapiro's (2012) classification (Figure 2), the Goals were almost evenly distributed between Content, Inquiry, and Skills, and are described by the author as follows: content – focus on content with the purpose of increasing students' content knowledge of math or science; skills – focus on skills with the purpose of developing students' process skills in math or science; inquiry – focus on inquiry with the purpose of developing inquiry skills in math or science. As seen before, the orientation motivation (focus on students' motivation with the purpose of increasing students' interest in learning math and science) was not found.

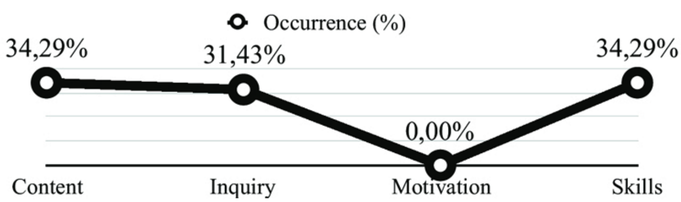

Figure 2. Occurrences of Wongsopawiro's (2012) goals in the analysed class.

The strategy that was greatly perceived (Figure 3) was lectures (use of didactic approaches such as direct teaching, lectures and classroom demonstrations), which also correlates with Magnusson's et al. (1999) orientations. In class, the PSTEs did not propose an experiment where the students could in fact experiment, they followed a script guiding them all the way, and even though the PSTEs interacted with the students it was only to lead them to answer correctly the main question of the class (pH interfere in the solubility of CO2).

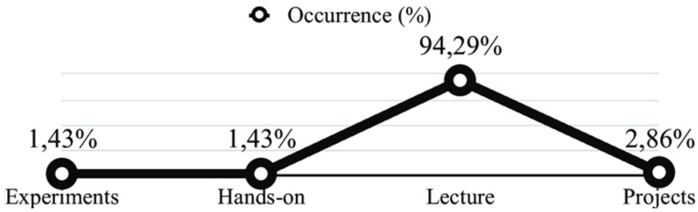

Figure 3. Occurrences of Wongsopawiro's (2012) intended strategies in the analysed class.

When analysing the co-occurrences between Magnusson's and Wongsopawiro's way of cataloguing those episodes, it can be perceived that they are in line with one another. There is a great association both between Didactic and the Goals Content & Skills and the Strategy Lecture, showed both by a high co-occurrence (Table 2) and by a c-index (Table 3).

Table 2. *Cooccurrences of Wongsopawiro's (2012) and Magnusson's et al. (1999) orientations in the analysed class (highlighted the bigger cooccurrences).*

Wongsopawiro\Magnusson		Activity-driven	Didactic	Inquiry	Process	Sum
Intended strategies	**Experiments**	1.67%	0.00%	0.00%	0.00%	**1.67%**
	Hands-on	0.00%	1.67%	0.00%	0.00%	**1.67%**
	Lecture	0.00%	58.33%	13.33%	25.00%	**96.67%**
	Projects	0.00%	0.00%	0.00%	0.00%	**0.00%**
Goals	**Content**	0.00%	32.73%	3.64%	7.27%	**43.64%**
	Inquiry	1.82%	7.27%	1.82%	12.73%	**23.64%**
	Motivation	0.00%	0.00%	0.00%	0.00%	**0.00%**
	Skills	0.00%	25.45%	0.00%	7.27%	**32.73%**

Table 3. *c-index of Wongsopawiro's (2012) and Magnusson's et al. (1999) orientations in the analysed class (highlighted the bigger c-index).*

Wongsopawiro\Magnusson		Activity-driven	Didactic	Inquiry	Process	Sum
Intended strategies	**Experiments**	1.00	0.00	0.00	0.00	**1.00**
	Hands-on	0.00	0.02	0.00	0.00	**0.02**
	Lecture	0.00	0.49	0.12	0.22	**0.83**
	Projects	0.00	0.00	0.00	0.00	**0.00**
Goals	**Content**	0.00	0.38	0.07	0.11	**0.56**
	Inquiry	0.05	0.07	0.03	0.23	**0.37**
	Motivation	0.00	0.00	0.00	0.00	**0.00**
	Skills	0.00	0.27	0.00	0.11	**0.39**

The orientation Process, on the other hand, correlates with Lecture and Inquiry. As seen before, Lecture was the main Strategy, and as such, has a large number of co-occurrences and strong correlation with Magnusson's et al. (1999) orientations. The orientation Process combines the thinking processes (reasoning) and the activities for a scientific investigation, which, if regarding at each definition, would correlate to the Goal Inquiry and the Strategy Project or Experimentation. However, in the analysed class, it is related only with the Strategy Lecture, notwithstanding of being in a laboratory, which by its own nature has preponderantly empirical resources. That indicates an inability to use the resources effectively from a laboratory to develop the "scientific skills" in a way other than the traditional lecturing. Grossman (1990) shows that teachers resort greatly on their experiences as students when teaching, therefore, to use those resources skilfully "they must experience such learning environments themselves" (Nilsson & Loughran, 2012, p.701). As a matter of fact, a privileged place to supply PSTEs with different experiences and "strengthen their content knowledge and pedagogical content knowledge while being exposed to the type of teaching consistent with the recommendations of the reform movement" is the university (Barrett & Green, 2009, p.20).

Differently from the previous correlations, there is a perfect c-index between Experiment and Activity-driven. Nevertheless, it does not come with a great co-occurrence, but this can be justified by the extremely low occurrence of both.

The chronologic appearance of the codes also brings relevant insights into the class dynamics. The Didactic orientation happens more frequently at the end of the class (third third) (Figure 4) and, as it correlates with the Goals Content & Skills and the Strategy Lecture, they also make its presence known by the end (Figure 5). The process is also more frequent in the end, despite being the main orientation in the middle of the class (second third), when the PSTEs begins to highlight, to the high schoolers, relevant aspects of the experiments, and also, to instigated them to step in the investigation process.

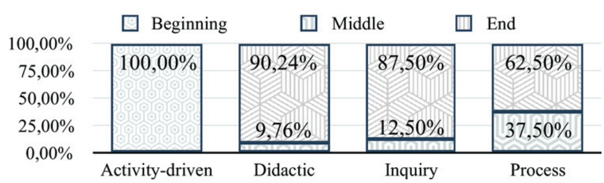

Figure 4. The chronologic appearance of Magnusson's et al. (1999) Orientations in the analysed class.

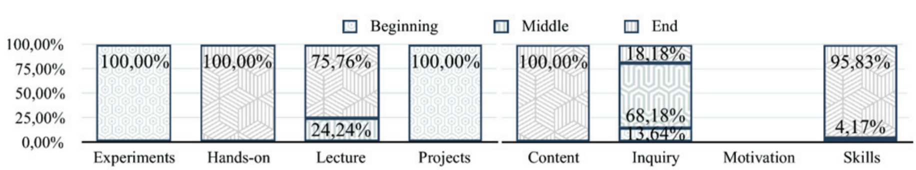

Figure 5. The chronologic appearance of Wongsopawiro's (2012) strategies (Experiments – Projects) and goals (Content – Skills) in the analysed class.

The moment the discussion was made (end) excels in lecturing approach, as seen before, with a focus on content and mental skills passing over practical activities. The intention, then, is to discuss the experiment made recapturing the content worked in the experiment and to generalise, correlating it to other chemistry subjects. Such practice is supported by Schneider's (2014) argument that coherent programs that increase PSTEs capability to reflect about science must "focus on knowledge, skills, and understanding with articulation between courses and field experiences [and] continuous instruction for learning about teaching" (p.1). The other strong relation, between the Activity-driven orientation and Experiments Strategy, happens only in the beginning of the class when the experiment is proposed.

Regarding the Discursive Interactions (Mortimer & Scott, 2002), it can be said that the Teachers' intentions were Exploring and probing students' views, followed by Guiding students to work with scientific ideas and supporting internalization; the Content was mainly Description; Communication was abundantly Interactive/Authoritative, with 90.36% of the communicative approach; the Interaction pattern used excelled in I-R-P-R-E and; the Teachers' interventions focused on Shaping meanings and Sharing meanings (Table 4).

Table 4. *Summary of the discursive interactions (Mortimer & Scott, 2002) in the analysed class.*

Teacher's intentions:	Exploring and probing students' views	46.99%	**Content:**	Description	51.22%
	Guiding students to work with scientific ideas and supporting internalisation	20.48%		Generalization	30.49%
	Introducing and developing the scientific story	14.46%		Explication	18.29%
Teacher' intervention:	Shaping meanings	33.33%	**Communicative approach:**	Interactive/ Authoritative	90.36%
	Sharing meanings	20.99%		Non-interactive/ Authoritative	9.64%
	Checking students understanding	16.05%	**Interaction patterns:**	I-R-P-R-E	65.91%
				I-R-E	34.09%

Research has shown that the Authoritative approach, is the most abundant in classrooms around the world (P. H. Scott et al., 2006), and the same study claims that the I-R-E pattern is the one that more intimately relates with the Authoritative approach, but that is not the case here, wherein a more elaborated one (I-R-P-R-E) was found. Netz (2014) warns us about the dangers of the I-R-E sequence, as it does not leave room for students' autonomous participation, and also about chained sequences, as the one found here, are an opportunity to an educative conflict. Hall & Walsh go further (2002) reckoning that “by asking them to expand on their thinking, justify or clarify their opinions, or make connections to their own experiences, the teacher-[enhances the] opportunities for learning” (p.190). However, despite escaping the traditional I-R-E pattern, a dialogic discourse is not reached, and it is vital to the thoughtful science literacy (Van Bramer, 2003).

From the excerpt below retrieved from the second third of the class (middle), it is possible to notice the foremost Discursive interaction observed. In it, the PSTEs probes the students to tell the results of their experiments, but the answer that satisfies the PSTEs is basically a description of what they are seeing. In the first six lines the Interaction pattern is I-R-E, which is said to be the traditional way and the most frequent teaching pattern (Hall & Walsh, 2002), and in this case, the final Evaluation I was given by the PSTEs writing the correct response on the blackboard, however, the next lines the students do not respond what is expected and then, and only in this type of circumstance, the PSTEs do not give an immediate feedback and tries to prolong until the Evaluation (I-R-P-R-E). The Interactive way by which the content was developed can also be perceived, as well that the PSTEs do not accept any idea that contradicts their line of thought, characterising an Authoritative approach. Finally, this segment of the class the Teachers’ interventions, illustrates the Sharing meanings (first eight lines) and the Selecting meanings (last six lines), it shows a different Intervention when the students agreed and gave the right response, and when they do not, and it is possible to realize that the Intervention is related to the Pattern of interaction.

PSTE 1: In the flask 1, what kind of water you put?

Students: Distilled.

PSTE 1: Distilled water, and before you blow with the straw, which was the colour?

Students: Yellow.

PSTE 1: Yellow.

Students: Yellow. Green. Orange [the Teacher 1 writes ‘yellow’ on the blackboard].

PSTE 2: After you blew what colour it was?

Students: Orange. Green.

PSTE 2: You have to get a consensus.

Students: Orange.

PSTE 2: And after you have warmed?

Students: Green. Orange. Purple.

PSTE 2: One person per group talks, one by workbench [points to a group]. What colour was it?

Students: Yellow.

PSTE 2: And yours?

Students: Green.

The chronological distribution of the Orientations has much to do with the communicative approach used by the PSTEs (Table 5), and Mortimer & Scott (2006) have shown how important such variation along the class is. The relation between the orientations and the Discursive interaction rise in the case we divide the class by moment. At the beginning of the class, the PSTEs main intention was to open the problem, which correlates with Inquiry and Projects (c-index of 0.67 and 1.00 respectively). They described the situation they wanted the students to investigate in an Interactive/Authoritative way, an I-R-E pattern, and interventions directed to Shape meanings. Then, the PSTEs let the students work on their experiments, having only a few interactions with them. In the middle of the class, it is possible to see a strong correlation between Goal Inquiry and Strategy Lecture, and, differently from the beginning, at this moment, a greater variety of situations can be seen. In it, the PSTEs tried to retrieve from the students the results of the experiments and to highlight important facts to construct a scientific reasoning. The correlations between the Orientations and the Discursive interaction had a c-index of ≈ 0.70 in the majority of the cases, but with the larger number of episodes the Interaction pattern was divided between I-R-E and I-R-P-R-E, and the Interventions between Shape meanings and Sharing meanings, as seen in the excerpt above and the Table 5.

Table 5. *c-index between the discursive interactions (Mortimer & Scott, 2002) and the Wongsopawiro's (2012) orientations in the analysed class*.

	Beginning		**Goal** Inquiry	**Strategy** Projects
Discourse interaction	**Teacher's intentions**	Opening up the problem	0.67	1.00
	Content	Description	0.67	1.00
	Communicative approach	Interactive/Authoritative	0.67	1.00
	Interaction pattern	I-R-E	0.67	1.00
	Teacher's interventions	Shaping meanings	0.67	1.00
	Middle		**Goal** Inquiry	**Strategy** Lecture
Discourse interaction	**Teacher's intentions**	Exploring and probing students' views	0.71	0.76
	Content	Description	0.67	0.71
	Communicative approach	Interactive/Authoritative	0.71	0.76
	Interaction pattern	I-R-E	0.38	0.35
		I-R-P-R-E	0.19	0.18
	Teacher's interventions	Selecting meanings	0.77	0.26
		Sharing meanings	0.04	0.56

End			Goal		Strategy
			Content	Skills	Lecture
Discourse interaction	Teacher's intentions	Exploring and probing students' views	0.02	0.32	0.26
		Guiding students to work with scientific ideas and supporting internalisation	0.25	0.05	0.06
		Introducing and developing the scientific story	0.38	0.06	0.24
	Content	Generalisation	0.36	0.17	0.39
		Description	0.02	0.34	0.27
	Communicative approach	Interactive/Authoritative	0.36	0.39	0.76
		Noninteractive/Authoritative	0.14	0.07	0.12
	Interaction pattern	I-R-P-R-E	0.29	0.33	0.44
		I-R-E	0.00	0.12	0.12
	Teacher's interventions	Sharing meanings	0.02	0.04	0.08
		Checking students understanding	0.23	0.13	0.19

The ending presented the greatest variance in the Discursive interactions, being marked by the Strategy Lecture, and divided in the Goals Content and Skills. The Teacher's intentions: Exploring and probing students' views had a stronger correlation with Skills and both Guiding students to work with scientific ideas and supporting internalisation, and Introducing and developing the scientific story with Content. There was a correlation between Description with Skill as well as Generalization with Content. The Communicative approach was still almost only Interactive/Authoritative, but for the first time had some moments of Non-interactive/Authoritative. The interaction pattern was, as before, divided between I-R-E and I-R-P-R-E, but at this moment, prevails the last. The Interventions did not present strong correlation, being Sharing meanings and Checking students' understanding the highest. The fragment of the class presented below shows the moment when the discourse changes from interactive (first 2 lines) to non-interactive (last line):

> PSTE: Evaporates a little? You think this could evaporate for example? Someone agrees, someone thinks differently?
>
> Student: Since we've put in only 5 min here it was not enough time, but if we leave more could be that all evaporate.
>
> PSTE: Right then, we already know that the CO2, that is what we've add, and that the reverse happens when we heat. What really comes out is only CO2. But look just how that is interesting: as the CO2 leaves, look here [points to the blackboard], it is missing something here. The chemical reactions ….. there are those chemical

> reactions that ….. for example, the barbecue on Sunday, we are burning coal with oxygen and releasing a lot of CO2 for the atmosphere, right? There are some other things but it is not relevant now.

Despite being notably absent from science classrooms around the world (P. H. Scott et al., 2006), the literature points to the importance of a dialogic discourse (Rollnick & Mavhunga, 2015), once it helps students to ponder and to construct by themselves the arguments of the accepted science (P. H. Scott et al., 2006). The dialogic discourse is the recognition of other ideas, and can be recognised when: "Students express their own thoughts […]; the teacher and individual students engage in an extended series of questioning […]; student/student exchanges involve one student trying to understand the thinking of another" (P. H. Scott et al., 2006, p.607). Those conditions are not found in this class, particularly the exchange between students. Here, it is clear the teacher's central role to decide the correct answer and to focus students' attention on just one meaning, which categorises the traditional way of teaching (Luft et al., 2011; van Zee & Minstrell, 1997).

The importance of teachers orientations in a classroom is also largely defended (Friedrichsen & Dana, 2003; Rollnick & Mavhunga, 2015; Samuelowicz & Bain, 2001; Veal, Makinster, & Ave, 2014), but while some studies claim to establish a relation between traditional orientations (when teachers believe their role to be the main provider of information), and traditional practices (teacher centred and authoritative), and between learner centred orientations and learner centred practices (Luft, 2009; Luft et al., 2011; Vavrus, Thomas, & Bartlett, 2011); some show an inconsistency between the two variables (Mansour, 2013).

These inconsistencies may be explained by the natural and necessary combination of both traditional and constructivist ways of teaching. Mortimer and collaborators (Mortimer, Machado, & Andréa, 2000; Silva & Mortimer, 2011) demonstrate the importance of the change in the discourse during the class. They, without denying the importance of the dialogic discourse, point out that the scientific discourse is authoritative by its own nature, and teachers must possess expertise in both approaches, developing a "teaching spiral" covering all discourses types, dialogical, authoritative, interactive, and non-interactive, toward a "content transformation." Scott, Mortimer & Ametller (2011) make the importance of "making links between […] existing knowledge and new ideas" (p.4), and its essential role in making meaningful learning clear. That demands a dialogical approach to bring the existing knowledge (from the students), but also, they put the responsibility of making those links on the teacher, which is an authoritative assumption. Those works attest the value of looking to the class not as a single event but as an interconnected and chained sequence of events, and each of them with a correlation between teachers' orientations and discursive interactions. In the case presented here, the orientations and the interactive discourse were deeply related when the unit of analysis was each moment of the class, and, despite the discourse never reaching a dialogic approach, as in the work of Mavhunga & Rollnick (2016), some movement could be perceived. It also interconnects the findings of researchers that have found a correlation between the phenomena and those who do not, as it brings light to the different flow that occurs.

The way novice teachers conduct their class is heavily influenced by their experiences in college (Grossman, 1990), in that manner, they need a high-quality formation (Chamoso, Cáceres, & Azcárate, 2012), including both traditional and constructivist ways of teaching. Assuming that the orientations impact the praxis and that, in this moment of the professional life, those are still in development, is easily changeable, “thoughtfully designed programs that address their ongoing learning needs is needed” (Schneider, 2014, p.1).

CONCLUSIONS

The importance of the orientations to teaching science is notorious throughout the literature. They act as a filter or modulator that guides teachers’ practices. Several ways of classifying them have been proposed, being the one presented by Magnusson et al. (1999) the most influential. Recently, such summarisation has been criticised, and Wongsopawiro (2012) proposes a new way to address this aspect of the teacher world. Here, our first aim was to verify if there is a correlation in those two referential. The results have shown a high frequency of Magnusson’s Didactic, and Wongsopawiro’s Goals: Content, Inquiry and Skills, and the Strategy Lecture. The orientation Didactic presented a strong correlation with Lecture, and smaller but also strong, with Content and Skills. Lecture in the same way correlated with Process, but in a minor scale. The greatest correlation, expressed by the c-index 1, was found between the orientation Activity-driven and the Strategy Experiment, even though both appear in a very small number of cases.

Once established this primary correlation, the second objective was to look for correlations with the Discursive interactions of Mortimer and collaborators. As shown above, despite several authors defending that the orientations directed their practice, and trying to correlate teacher-centred orientations with teacher-centred praxis and student-centred orientation with student-centred praxis, few reach such conclusion, and the dilemma persisted. Quod erat demonstrandum, in this paper, it was possible to achieve this correlation the moment the class was divided into segments. The Interactive/Authoritative Approach had a c-index near 0.7 in all correlations being the most significant. Surprisingly, the Interaction pattern more frequent was the chained I-R-P-R-E with c-index ranging from 0.29 to 0.67. As Mortimer defends, a movement of Discursive interactions was found, but the Dialogical Approach was not among them.

We have demonstrated the importance of not looking at a class as a whole but as a chained sequence of events. Also, that the orientations presented do in fact correlate with the practice. Further studies focused on temporal precedence, are needed to determine if there is causation between the two phenomena or at least an INUS condition.

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