

## **From modelling the teaching practice to the establishment of relations between the teacher's actions and cognitions**

Carlos Miguel Ribeiro

*University of Algarve, Portugal*

In modelling the teacher practice, we approach some cognitions of the teacher while (s)he is immersed in action. To do this, we elaborate a model, which has been theoretically and practice based, which allows us to display apparent links and relations between the teacher's actions and his/her goals, beliefs and knowledge. In this paper I will present the modelling process in one specific situation where the teacher presents a certain content and, by doing so, I will show what and of what kind of relations occur in those specific situations.

**Keywords:** Cognitions, modelling the teacher's practice, mathematics education

### **Introduction**

Teaching practice is influenced by a wide range of variables. The way teachers consider the teaching process, their role and that of the students is related to how they deal with all those variables. From all the range of variables involved the ones I consider most influence the teacher's practice are the teacher cognitions (beliefs, goals and knowledge). None of these aspects can be seen in an isolated way because they are interdependent and directly connected with the teacher's previous experiences. These cognitions are reflected in the classroom interactions and thus, the more we know about the way they influence the teaching process, the better we can understand it (Aguirre & Speer, 2000; Ernest, 1989; Schoenfeld, 1998b).

Also, the way the teacher communicates and interacts with others, in particular with the students, may reveal how (s)he considers the teaching process must occur. In particular, if the teacher uses distinct types of communications it may correspond to distinct didactic approaches. These variables, and the way they relate, will be the focus of my attention in this paper. It is part of a wider research project, which aims to improve our understanding about which cognitions underlie teachers' actions in their practice in a mathematics class and how they are related and change during time (also as a result of collaborative work). To be able to analyze all the relations, we elaborated a model based in the one presented by Monteiro, Carrillo, & Aguaded, (2008); Schoenfeld, (1998a) and Schoenfeld, Ministrell, & Zee, (2000).

### **The components of the model**

The option of elaborating a model is based on the fact that the teaching-learning process is far too complex to permit a single, all-encompassing analysis. However, we choose to focus on teachers' actions and cognitions as well as their relations, because these are of supreme relevance to understanding the practice. The model is actualized as we engage in the analysis through constant comparisons between the previous analysis and the new information gathered (Strauss & Corbin, 1997). At the moment,

the central components of the model are the teacher cognitions, their actions and the type of communication used; however, it also reveals which resources are used, the means of working, the teacher's specific goal at each moment, the type of episode, whether the episode is part of the lesson image, the triggering and terminating events and also the teacher's actions each time. I will briefly discuss each of these components (excluding the teacher's actions, because these are directly observed from the classroom/video recordings – Cf. Methodology).

A goal may simply be something which one aims to attain (Schoenfeld, 1998b). The teacher may have different kinds of goal and these may be over the short, medium and long term, explicit or latent, and thus part of a system. They can likewise be pre-determined or emerge during the teaching activity (Aguirre e Speer, 2000). Like Saxe (1991), we consider that each individual has the capacity to construct, adapt, model and remodel such goals in accordance with his or her own personal and professional development.

Teachers' beliefs have a significant role in their teaching process (Ernest, 1989). To analyze them we consider a set of belief indicators taken from Climent (2002). Climent presents a set of indicators of primary school teachers' beliefs (i.e., first six years in Spain), with respect to beliefs concerning methodology, mathematics, learning, and the roles of pupil and teacher.

With the aim of analyzing the professional knowledge, we have selected the categorization presented by Ball, Thames, & Phelps (2008), which adapts Shulman's (1986) formulation of the components of professional knowledge. We take their current proposal and incorporate certain descriptors from Park & Oliver (2008). Ball et al. (2008), divided both content knowledge and pedagogical content knowledge into three categories. The former is composed of horizon knowledge (HK), common content knowledge (CCK) and specialised content knowledge (SCK). The latter is likewise divided into three types, each a variant of content knowledge: teaching (KCT), students (KCS), and the curriculum (KC). The distinctions between CCK and SCK may be problematic when analysing teacher's practice (Ball, Thames et al., 2008) (what is assigned to each category and for who?) and also, depending on the focus of the analysis, the KCT can be seen as SCK or vice versa.

As mentioned previously, the type of communication the teacher uses has a direct relation to the way (s)he considers the teaching process must occur. I will make use of the classification of mathematical communication proposed by Brendefur & Frykholm (2000): unidirectional, contributive, reflexive and instructive, with some adaptations introduced by Carrillo, Climent, Gorgorió, Rojas, & Prat (2008).

The type of episode is also part of the model. This corresponds to routines, scripts or action guides, and improvisations (Ribeiro, Monteiro, & Carrillo, 2009; Schoenfeld, 2000; Schoenfeld et al., 2000), whether each specific episode we consider is part of the lesson image, and information related to the triggering and terminating events. A routine is any kind of action independent of context, executed routinely; scripts, or action guides, are specialisations of routines, but conceptually dependent. Improvisations correspond to all those actions undertaken by the teacher in response to an unexpectedly arising event. The lesson image corresponds to what the teacher (immediately before the class starts) says is going to happen (this is not the same as the lesson plan). The triggering and terminating events are those which delimit each episode.

## Methodology

To model the teaching practice and establish some relations between the model elements, we combine a case study with an interpretative methodology. The data collection includes audio and video recordings (in the interactive stage of teaching, centred on teachers) and informal conversations obtained before and after class (to get the lesson image and clarify some inferences). All the audio recordings were transcribed and then complemented with information from the video concerning the teacher's actions and interactions with the pupils (Star & Strickland, 2008). This occurred at three different times, but always when the (two) teachers were going to introduce new content (in the 4<sup>th</sup> grade – students aged 8 or 9). In this paper I will discuss one specific situation regarding the first phase, where one of the teachers presents the content (how to write thousandth and hundredth in the orders table) in a unidirectional way, for the entire group using the board. I will focus my attention on the relations obtained between the model elements (in particular the teacher actions, type of communication and cognitions) rather than in the model itself.

The elaboration of the transcriptions corresponds to the first phase of analysis – identifying triggering and terminating events as well as the teacher's goal (which defines if it is an episode of revision, presentation, ...), the type of episode and the resource(s) used. After that, the identification of the indicators of beliefs and teacher's knowledge has been done. The indicators of beliefs of each type of episode correspond to the intersection of the ones identified in all of them, and the knowledge corresponds to the correspondent union of all the knowledge components in every episode of the same kind. After all the model was build a macro analysis to each type of episode was done to determine the relations between the model components, which allows us to try to understand their influence in teacher's practice.

## Some findings

From the modelling process, and concerning the type of episode under analysis (presenting the content in a unidirectional way, for the whole class using the board), the teacher fulfils her goal (to present the content) through a set of actions. As it is an episode in which the teacher's goal is to present the content and by that use the board, two of her actions are directly related to that goal. These are: the action of presenting the content, and the one of writing on the board. In all the episodes where her goal is to present some content, the actions of clarifying and reviewing are also included.

The way the teacher actually acts is related to the type of communication she uses, because the same kind of action may guide the teaching process in different ways, the type of communication being the more powerful source (associated to the actions) of information about the teacher's beliefs. When analysing the indicators of belief, we obtained a set of them related to the methodology (TR5 – no use of manipulative materials – and TR3– the main source of information for the students is the teacher and the textbook), to the teacher's role (TT26-29 – the teacher organizes the contents of the learning, which is transmitted by means of exhibition, using organised strategies that can look attractive – and TT30 – the teacher is the one who validates the information), to the learning process (TR16/TT16 – the interaction between teacher and students is not balanced, is stronger in the direction teacher-students) and also to the learning process (TT14 – the teacher presents the content simulating its construction, but the true learning is supported by him/her in a deductive process). It

is important to recall that these indicators correspond to the intersection of all the identified indicators in all the episodes of the same kind.

Concerning knowledge, the teacher evidences some of the components transversally, in the entire episode and others more related to a specific action (lines of the transcription). Transversally the teacher evidences a CCK, SCK and a KCT. The CCK is related to the fact of knowing how to represent, numerically, decimal numbers and in particular ten thousandth; the SCK concerns the fact of knowing the properties of writing numbers in the orders table (in particular one thousandth and ten thousandths), knowing how to read numbers by orders and that each order correspond only one value; the KCT is related to the need of the pupils to pay attention because this is the only way they will be able to answer the questions, and show what they have learnt, and is also related to the fact that the teacher considers that the board and the mini-presentation, associated to a unidirectional communication, are adequate to present this content (write hundredth and thousandth in the orders table).

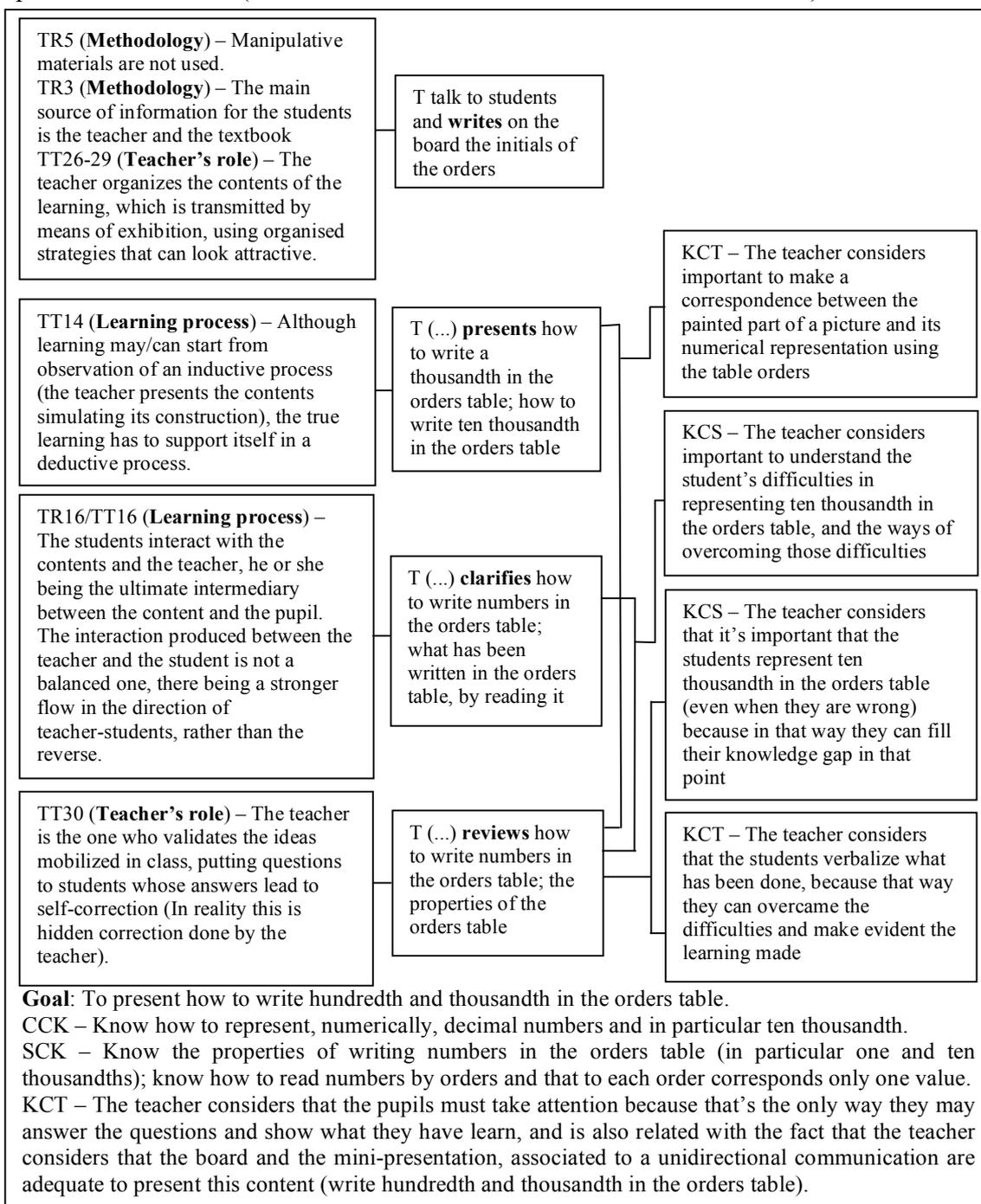


Illustration 0 – Relations between actions, beliefs (indicators) and knowledge in an episode of presenting

The knowledge components related to specific actions, in this case associated to the line transcriptions, concerns the KCT and the KCS. Concerning the KCT; from the analysis and the informal talks, we can say that the teacher considers it important to make a correspondence between the painted part of a picture and its numerical representation using the table orders, and also that the students verbalize what has been done, because that way they can overcome the difficulties and make evident the learning made. With respect to the KCS, the teacher considers it important to understand the student's difficulties in representing ten thousandth in the orders table, and the ways of overcoming those difficulties; he/she also considers that it is important that the students represent ten thousandth in the orders table (even when they are wrong), because in that way they can fill the gap in their knowledge at that point.

In Illustration 1 above, the relations between the teacher's actions, knowledge and beliefs (indicators) are presented. The (...) must be substituted by: talks to students and, in a unidirectional way, by using the board. As the knowledge components are directly related to the teacher specific goals, I refer explicitly to what these specific goals are in each situation. The actions of presenting and clarifying occur twice in this episode and the two specific goals and knowledge are presented together.

### **Discussion and final comments**

The previous illustration intends to evidence the kind of relations obtained from the analysis, but I must note that in a two-dimensional representation we can hardly represent all of them due to their degree of complexity. The relations presented on the left side, between actions and indicators of beliefs, are general relations which occur in all the episodes in which the teacher presents a certain content using a unidirectional communication. In all the episodes some actions are, and consequent associated beliefs, assuming the main role in the teachers' practice. These are considered to be activated with priority. In this category of episode the main role is assumed by the action of presenting the content and by an indicator of beliefs concerning the learning process (TT14).

The right side corresponds to the knowledge components which depend on the teacher specific goals and are then associated to a specific part of the class. Some knowledge components are related to two distinct actions which also evidences the complexity of the teaching-learning process. Another of those evidences is the fact that these actions do not occur always in the same order, neither need they all to occur in all the episodes of this kind, but at least the actions of presenting and writing on the board must occur for an episode to be considered similar to this one (which has the same category of goals).

From the elaboration and analysis of the cognitive model, we can say that the teacher's beliefs are consistent with her actions and goals. They arise from practice and sometimes explicitly from the informal talks before and after the class. This kind of analysis allows us to obtain a wide understanding of the teacher's practice and, if it is done by the teacher him/herself, it may be a first step to being aware of their own cognitions and their role in the way they face the teaching process. It may ultimately,

on reflection (Schön, 1983), lead to a sustainable change in their practices. It can even attain a higher pattern of reflection and, by that, open up the teachers' range of vision about all the different possibilities and approaches, if this kind of discussion is based on the mathematical critical moments identified by the teacher in his/her own practice.

From the kind of information gathered through this analysis, such an analysis may also be used in professional development programs or in the sphere of collaborative groups, as a way for teachers to become aware of their own cognitions and actions and the way they influence their practice. This would be our next step.

## References

- Aguirre, J. and Speer, N. (2000). Examining the relationship between beliefs and goals in teacher practice. *Journal of Mathematical Behavior*, 18(3): 327-356.
- Ball, D., Thames, M. H. and Phelps, G. (2008). Content knowledge for teaching: what makes it special? *Journal of Teacher Education*, 59(5): 389-407.
- Brendefur, J. and Frykholm, J. (2000). Promoting mathematical communication in the classroom: two preservice teachers' conceptions and practices. *Journal of Mathematics Teacher Education*, 3: 125-153.
- Carrillo, J., Climent, N., Gorgorió, N., Rojas, F. and Prat, M. (2008). Análisis de secuencias de aprendizaje matemático desde la perspectiva de la gestión de la participación. *Enseñanza de las Ciencias*, 26(1): 67-76.
- Climent, N. (2002). *El desarrollo profesional del maestro de Primaria respecto de la enseñanza de la matemática. Un estudio de caso*. Doctoral thesis, (Published in 2005. Michigan: Proquest Michigan University. [www.proquest.co.uk](http://www.proquest.co.uk)).
- Ernest, P. (1989). The Knowledge, beliefs and attitudes of mathematics teacher: a model. *Journal of Education for Teaching*, 15(1): 13-33.
- Monteiro, R., Carrillo, J. and Aguaded, S. (2008). Emergent theorizations in Modeling the Teaching of Two Science Teachers. *Research in Science Education*, 38(3): 301-319.
- Park, S. and Oliver, J. S. (2008). Revisiting the Conceptualization of Pedagogical Content Knowledge (PCK): PCK as a Conceptual Tool to Understand Teachers as Professionals. *Research in Sciences Education*, 38: 261-284.
- Ribeiro, C. M., Monteiro, R. and Carrillo, J. (2009). *Professional knowledge in an improvisation episode: the importance of a cognitive model*. CERME6. Lyon, France. To appear.
- Saxe, G. (1991). *Culture and cognitive development: Studies in mathematical understanding*. Hillsdale: Lawrence Erlbaum Associates.
- Schoenfeld, A. (1998a). On modeling teaching. *Issues in Education*, 4(1): 149-162.
- Schoenfeld, A. (1998b). Toward a theory of teaching-in-context. *Issues in Education*, 4(1): 1-94.
- Schoenfeld, A. (2000). Models of the teaching process. *Journal of Mathematical Behavior*, 18(3): 243-261.
- Schoenfeld, A., Ministrell, J. and Zee, E. V. (2000). The detailed analysis of an established teacher's non-traditional lesson. *Journal of Mathematical Behaviour*, 18(3): 281-325.
- Schön, D. (1983). *The reflective practitioner: How professionals think in action*. Nova York: Basic Books, Inc., Publishers.
- Star, J. R. and Strickland, S. K. (2008). Learning to observe: using video to improve preservice mathematics teachers' ability to notice. *Journal of Mathematics Teacher Education*, 107-125.