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Teacher scripts in science teaching

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ABSTRACT

Awareness of teacher scripts is of crucial importance to reflection on practice, and represents one means of widening the scope of classroom performance. The first part of this work provides a full description of three scripts employed by a novice science teacher within the topic of The *Structure of Flowers*, and offers a detailed illustration (including a transcription excerpt, a routine, three scripts and an improvisation) of how these were derived by means of a Modelling Instrument (MI). In the second part, the relationships between beliefs and actions are explored through tree diagrams. Finally, there is a discussion of how entrenched scripts may act as obstacles to professional development.

1. Theoretical framework

To understand teaching is to understand the teacher's thinking and practice (Shulman, 1986a, 1986b), and this is fullest when these two domains, thinking and practice, are studied together and examined in relation to each other (Clark & Peterson, 1986). Several approaches are available to the researcher in this respect. Modelling teaching (Monteiro, 2006, Monteiro Carrillo, & Aguaded, 2007, 2008, 2009; Monteiro & Carrillo, 2009; Schoenfeld, 1998), for example, focuses on the teacher's cognitions (beliefs, knowledge, goals) and actions. We are aware that beliefs cannot be mapped directly onto practice, but they can provide an understanding of an individual's performance (Pajares, 1992; Richardson, 1996). Indeed, Schoenfeld (1998a, 1998b) believes that if, in a specific context, there is a good comprehension of the beliefs, goals and knowledge underlying a teacher's decisions and actions[1], then a coherent and detailed explanation of what that teacher did and why can be achieved. He proposes an instrument composed of three columns, the first specifying information about goals, knowledge and beliefs, along with the triggering and terminating events of each episode, the second providing an overview of the teacher's actions from a general perspective, and the final column giving a very detailed description of each action performed by the teacher.

This paper presents an instance of such modelling through the application of a Modelling Instrument (MI) (Monteiro, 2006, Monteiro, et al., 2007, 2008, 2009; Monteiro & Carrillo, 2009), derived from adaptations to Schoenfeld (1998a, 1998b, 2000), in addition to studies by Aguirre and Speer (1999), Cañal (2004), Carrillo (1998), Climent (2002), Santos (1991), Schoenfeld, Ministrell, and Van Zee (2000), Sherin, Sherin, and Madanes (2000), Shulman (1986a, 1986b, 1987), and Zimmerlin and Nelson (2000). The adaptations to Schoenfeld's instrument take two forms. On the one hand, the first column takes into account different dimensions relating to the teacher's knowledge. On the other, the second and third columns are conflated into one, as the focus of the paper is on the identification of meaningful action sequences and the context which produces them, rather than the accumulated minutiae of each brief action. This adaptation will be implemented in section three.

Through the application of the MI, a wide variety of scripts, routines and improvisations employed by a novice teacher was detailed, in respect of the topic *Plant Diversity*, of which three scripts are presented here by way of example, along with one routine and one improvisation, all sharing the theme *The Structure*

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[1] We adopt Leatham's (2006) perspective in that we assume that teachers have a sensible system of beliefs. As researchers, we do not focus on finding inconsistencies between beliefs and actions, but rather on understanding relationships between them and the (for us) apparent contradictions. Moreover, in this paper we do not deal with relationships between espoused beliefs (Contreras, 1999; Freitas, Jiménez, & Mellado, 2004; Raymond, 1997; Thompson, 1992) and actions, but with actions and beliefs that are inferred from the actions themselves (beliefs *in actions*).

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of Flowers. Of particular interest to this study are the scripts employed by the teacher, through which we aimed to capture the teacher's cognitions beyond his observable performance[2].

Scripts are theoretical entities, like routines and improvisations, which correspond to an action or to a sequence of actions in a specific context, conceptually dependent on the subject content, such as, in this instance, a science topic (the structure of flowers). People have at their disposal thousands of very personal scripts (Schank & Abelson, 1995) which they put to daily use, reducing the demands on their processing capacity in familiar situations (Schank & Abelson, 1977)[3].

The Modelling Instrument establishes the triggering and terminating events for each action sequence deployed in class by the teacher. Each action sequence is driven by an objective *in action*, necessarily activated at the point at which it is implemented.

Likewise, the action sequence has its associated beliefs *in action* which condition specific actions or the complete sequence of actions carried out by the teacher. The instrument used for establishing the teacher's beliefs at any particular moment was Monteiro's (2006) and Monteiro et al.'s (2008) procedure for analysing elementary science teachers' beliefs, which draws on Carrillo (1998) and Climent (2002). The indicators of this instrument are organised into categories (methodology, school science, learning, pupil role, teacher role and evaluation) and locates the beliefs within one of four tendencies: traditional, technological, spontaneous and investigative. It should be noted, however, that in using this instrument the researchers were not interested in allocating the teacher to one or other tendency, and in practice, the indicators were not applied in too rigid a fashion, not least because no individual can be said to belong unequivocally and uniquely to any specific category (Porlán, 1989).

In addition to specifying the beliefs and objective, the script also identifies the knowledge brought to bear at the implementation of the action sequence, and this corresponds to the knowledge *in action*. Following Schoenfeld (1998a, 1998b), Schoenfeld et al. (2000), and Shulman (1986b, 1987), the theoretical framework characterises this knowledge into three types (subject knowledge, general pedagogical knowledge and pedagogical content knowledge), with incorporations from Cañal (2004) and Santos (1991). Content Knowledge (CK) concerns the facts, terminology, and key concepts of the subject and specific topics within the subject. It also allows for the fact that the teacher may make errors (Cañal, 2004; Santos, 1991), for example by repeating the belief of his or her students that plants are nourished by soil and water. Pedagogical Content Knowledge (PCK) refers to the role played by analogy, exemplification, metaphor, illustration, explanation and demonstration (Shulman, 1986b, 1987), that is to say, the various strategies available for presenting the contents specific to science. General Pedagogical Knowledge (GPK) concerns the use of Socratic dialogue, interactive dialogue, unplanned dialogue and mini-presentation (Schoenfeld et al., 2000) in dealing with the contents in general.

[2] This study is not to be understood from a sociological perspective, focusing on the relationships between teacher and students, or on the classroom discourse (Morais, Neves, & Pires, 2004, chap. 6). The perspective in this paper is complementary to Morais, Neves, and Afonso (2005): whilst these authors deal with the improvement of teacher training in terms of recognition and realisation rules (interaction practices), this paper focuses on the teacher's cognitions.

[3] The theoretical construct *script* arose out of the work of Schank and Abelson (1977) in the field of cognitive and social psychology. A *script* is defined as a structured representation of a routinised sequence of events in a specific context, and has also been employed by and researchers within the field of artificial intelligence.

2. Methodology

This study followed an interpretative paradigm, as endorsed by Latorre, Del Rincón, and Arnal (1997), as opposed to positivist and socio-critical paradigms, with the aim of emphasising the understanding and interpretation of educational experiences from the perspective of those involved, and of studying their beliefs, intentions, motivations and other features unavailable to observation or experimentation.

Within an interpretative paradigm, it is assumed that the researcher takes a significant role with respect to the interpretation that is carried out (Bogdan & Biklen, 1994). In this respect there are two key elements relevant to the research process: *theoretical sensitivity* (Strauss & Corbin, 1994), deriving from the researcher's personal and research background, and *phenomenological sensitivity* (Van Maanen, 1988 in Geelan, 2003), which concerns the researcher's openness to the object of study and others' experience of it.

The design of study also took a naturalist approach (Lincoln & Guba, 1985) as the experiences to be studied were not to be divorced from their context but rather studied within their natural environment.

Given that the study was to focus fundamentally on specific issues concerning the cognitions and teaching of an individual, as opposed to generating research findings from which generalisations and broad abstractions could be made (Erickson, 1989), it was clear that a case study would be the most appropriate form to adopt, as this would allow the fullest understanding of the case in question (Stake, 1998).

Specifically, it was decided that the case study would produce a model of the teaching of a novice teacher, allowing the identification of routines, improvisations and scripts, and hence would provide detailed characterisation of his beliefs *in action*, objectives *in action*, knowledge *in action* and his actions themselves, in constant interaction during the teaching of a science topic. The emphasis on these dimensions being *in action* results from our aim to build an instrument (MI) which emerged from practice (consonant with the approach taken by Ball, Thames, and Phelps (2008) and not from solely what might be declared or desired by Rodrigo.

In brief, the main objectives of the study were the following: (1) To obtain highly detailed scripts for a novice science teacher; (2) To characterise cognitive elements of the teacher in interaction with his actions; (3) To explore, through tree diagrams, strong relations between beliefs *in actions* and actions on the part of the teacher's understanding of teaching (based particularly on previously transcribed scripts). These objectives derived from the following research questions: (i) What is the nature of science teachers' scripts? (ii) What is the nature of cognitions in action, and what part do they play in scripts? (iii) What does the analysis of scripts and tree diagrams bring to our understanding of classroom practice?

The interests of the study went beyond the questions above and were deeply concerned with the area of training and professional development. At the same time, it was not an aim to provide a characterisation of the teacher himself, the subject of the study, but to highlight the scripts employed by him within a science class, the object of the study.

With respect to the instruments for data collection, it was recognised that these would be determined in the course of the study itself according to the developing understanding of the project in conjunction with the literature review, and that in this sense it would follow an emergent design. Lincoln and Guba (1985) note that an emergent design within a naturalist study emerges in cascade rather than being determined beforehand, as it is impossible that the design can be fully known from the outset and can