Observing changes in teachers' practice as a consequence of taking part in professional development: developing a protocol for the observation of lessons

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In this paper we will describe the development of a system for lesson observation. This system has been designed to be used to observe changes in teachers' practices as a result of taking part in professional development (PD). The PD promotes and supports secondary mathematics teachers' use of inquiry-based learning and problem-solving. Many approaches to the evaluation of PD rely on the assessment of changes in teachers' thinking and beliefs, largely because of the complexity and difficulty of analysing practice. As part of a design-based research study, we are developing an observation protocol that allows the rapid analysis of a number of lessons. This involves identifying the lesson structure as an arrangement of episodes. In this way we are able to code episodes and identify changes in the nature and structure of the lesson. In this paper we will describe the ongoing development work and the system that has been developed and trialled so far.

Keywords: lesson observation, lesson structure, professional development, secondary, teachers

Introduction

This paper describes the development of an approach to lesson observation and lesson observation data analysis. The development of this approach is to serve multiple purposes on projects being undertaken by the Centre for Research in Mathematics Education (CRME) at the University of Nottingham (UoN). Steven is involved in a project involving the formative evaluation of professional development materials that promote problem-solving and inquiry-based learning. Sheila is designer and researcher on the Mathematics Assessment Project (MAP) funded by the Bill and Melinda Gates foundation. One of the aims of this project is to develop formative assessment lessons that promote teacher professional learning (Schoenfeld 2012).

The observation protocol (Teaching for Robust Understanding of Mathematics, TRU Math) has been developed by the MAP team led by Alan Schoenfeld at the University of California at Berkeley (UC). At CRME we are contributing to the development work through trialling and evaluating the coding scheme developed by the team at UC. In addition we are developing a complementary piece of work on lesson structure. We report here the development work on lesson structure analysis.

There are three important criteria that the lesson observation protocol must meet. First and second, the approach must yield valid and reliable results and third, the data analysis must be completed quickly and efficiently. It is expected that many tens, if not a hundred or more lessons will be observed across projects, with video-recordings made of these lessons. The aim is that for each one-hour lesson the coding will be completed in a further hour or so. The combination of the TRU Maths coding

and the development of the lesson structure model using the analysis we describe here provides a method that will facilitate rapid lesson analysis.

In this paper we begin with a general discussion concerning lesson observation which serves to remind us that observation is a complex and difficult means of evaluation. We draw on research into lesson structure to show it is a potentially useful and important feature of a lesson. We then consider the limited existing research on lesson structure and attempt to define lesson structure as the arrangement of episodes within a lesson. We take the position that lesson structure is a culturally and socially transmitted artefact that can be identified reliably using low-inference techniques. We then describe the lesson structure offered to teachers in the Bowland professional development materials and compare this with an archetypal lesson structure that is common in many mathematics lesson in England's secondary schools, what Burkhardt, Groves, Schoenfeld and Stacey call "exposition, examples, exercises…" (1988).

Finally we discuss how this might be useful in the evaluation of the effectiveness of professional development initiatives such as MAP or the Bowland professional development materials. At one level we can identify structural changes to practice, at another level lesson episodes can be coded using the TRU math coding system. Finally our structural analysis can be used as a system to navigate around and take sample episodes from large numbers of lessons for more detailed analysis.

Lesson observation

Lesson observation has its methodological origins in identifying teacher behaviours that relate to student outcomes (see for example, Flanders 1970). More recently there has been a body of work related to school and teacher effectiveness and this has relied on detailed teacher observation protocols (Muijs 2006, Kyriakides, Creemers and Antoniou 2009). There are a limited number of studies that use lesson observation as a basis for evaluating PD and the implementation of inquiry-based learning in science (Sawada et al. 2002, Heath et al. 2010, Marshall et al. 2011). A further source of lesson observation research in school mathematics comes from international comparative studies (Stigler and Hiebert 1999, Clarke, Keitel and Shimizu 2006). While there is much rich data to be gleaned from the observation of lessons, it is also important to be cautious about the how the data is measured, analysed, validated and the conclusions that can be drawn. A recent study has shown that even expert judgements of lessons can be fallible (Strong, Gargani and Hacifazlioğlu 2011). Lesson observation results in the generation of large amounts of data. This, in itself, can make the use of lesson observation time consuming and, as a result, ineffective. In an attempt to overcome this, Beeby, Burkhardt and Fraser (1979) developed a real-time lesson coding system that resulted in data reduction at the collection stage. This was achieved through focussing on the main aspects of the lesson and its structure. In this paper we focus on lesson structure, building in part, on the work of Beeby et al (1979).

What do we mean by lesson structure?

There is no definitive answer from the literature of what lesson structure is, although the idea of lesson structure has been defined from a variety of perspectives. Here, we take it to mean the hierarchy or arrangement of episodes or passages of a lesson that are related yet have distinct features. Historically, an influential lesson structure in European and North American schools has been attributed to the German philosopher

and pedagogist, Johann Friedrich Herbart (1776-1841) (Dunkel 1969). The following is an example of a Herbart type structure:

1. Constructing cognitive clarity of the previously learned material,
2. Integrating the elements of the new knowledge by relating them to the knowledge already learned,
3. Systematizing these associations,
4. Applying the new knowledge (cited in Maulana *et al.* 2012).

This structure is familiar in many lessons and would include episodes that feature a review of previous work, and teacher exposition in which prior learning and knowledge is related to the current lesson. This is followed by demonstration of new methods and approaches followed by student practice of the teacher-defined approach. Lesson structure has been influenced in England, in recent years, by the introduction in secondary schools of the National Strategies which emphasised the use of whole class interactive teaching (Bangs, Macbeath and Galton 2010) and review episodes referred to as plenary sessions.

For our framework we draw on the terminology used by Beeby, Burkhardt and Fraser (1979, 7). They considered lessons as "levels of action" at different time-scales: the *event*, the *episode* and the *activity*. They suggested that a lesson can be divided into a series of *activities*; an activity being the largest sub-unit of a lesson with consistent aims. For example, teacher exposition may alternate with student practice. In their framework they use *episode* as a sub-division of an *activity*. Thus an *episode* might feature a teacher talking to one student and then moving to another and in so doing they start a new episode within the same activity. The smallest scale unit is the *event* which represents a single happening or linguistic piece within their *episode*. Although we use similar definitions our conception of 'episode' is consistent with what Beeby, Burkhardt and Fraser describe as an 'activity'. We have done this to avoid confusion where activity may refer to the learning task. For us the episode is the largest sub-unit of a lesson.

More recently, Schoenfeld (2012) considers episodes as '…periods of time during which the class is engaged in one relatively coherent type of classroom activity'. Activity types identified are:

- Task introduction
- Mathematical discussion
- Small-group work
- Independent student work
- Post-lesson analysis.

In the next section we will compare the lesson structure proposed in the Bowland professional development materials and compare this with a more traditional teacher-centred structure that is common in secondary school mathematics lessons in England.

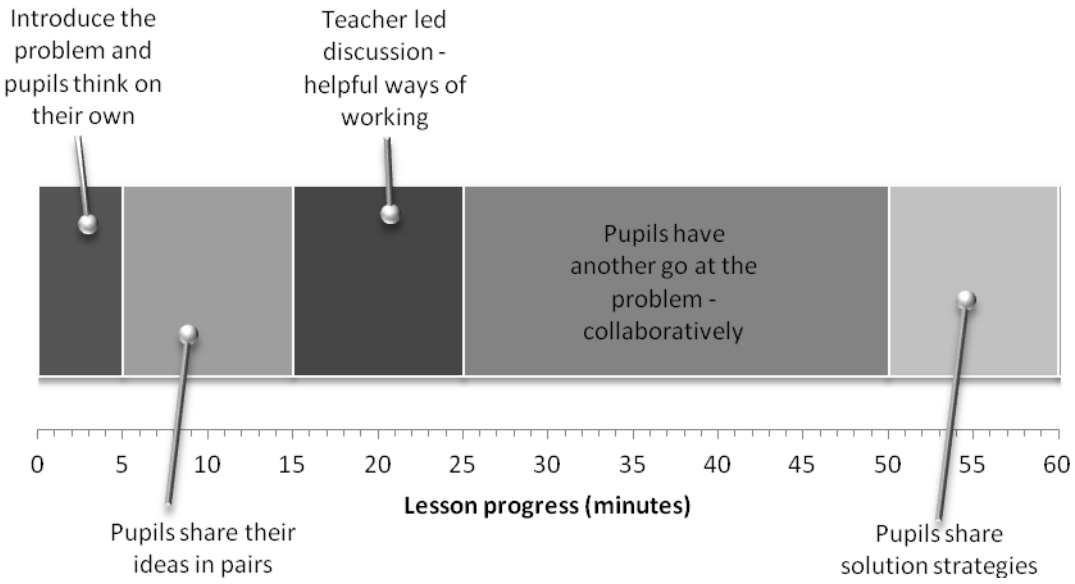

Figure 1 Bowland PD; *fostering and managing collaborative work*, model lesson structure.

The structure of a student-centered lesson compared with a 'traditional' lesson

To illustrate this we will describe the structure of a lesson used in an example video from the Bowland professional development modules (see Figure 1). The structure of the lesson is such that after a brief introduction by the teacher, pupils work individually on the problem. This first episode lasts about five minutes. In the following episodes pupils are given about ten minutes to share their ideas within a small group, this is then followed by a teacher led discussion. Pupils are then given 25 minutes to have another go at the initial problem before presenting their solutions in the final ten minutes of the lesson. In contrast Figure 2 illustrates the structure of a more traditional lesson which was observed as part of our data-collection. The formation of this structure can be traced to several sources. Clearly Herbart's structure is evident in the way new ideas or methods are introduced in a systemised way. The two tier or hierarchical structuring has been influenced by the introduction of the National Strategies in 2001 (DfEE 2001). This led to the introduction of the three-part lesson which featured a 'starter', the main part of the lesson and a plenary with timings typically found as shown in Figure 2. The main part of the lesson often features cycles of teacher exposition, students working on problems followed by a whole-class answer checking activity. In Figure 2, this is illustrated as two cycles in the expanded main part of the lesson. This allows teachers to develop a routine skill incrementally.

Validating the analysis of structure

In order to determine how useful and reliable these structures are, we have compared the traditional structure with so-called traditional lessons (this comparison was presented during the BSRLM day-conference session) and the model is largely consistent with the real lessons. Similarly we compared the student-centred lesson

structure with a 'real' lesson and found reasonable correspondence. Further work is needed to develop the models and develop the approach further.

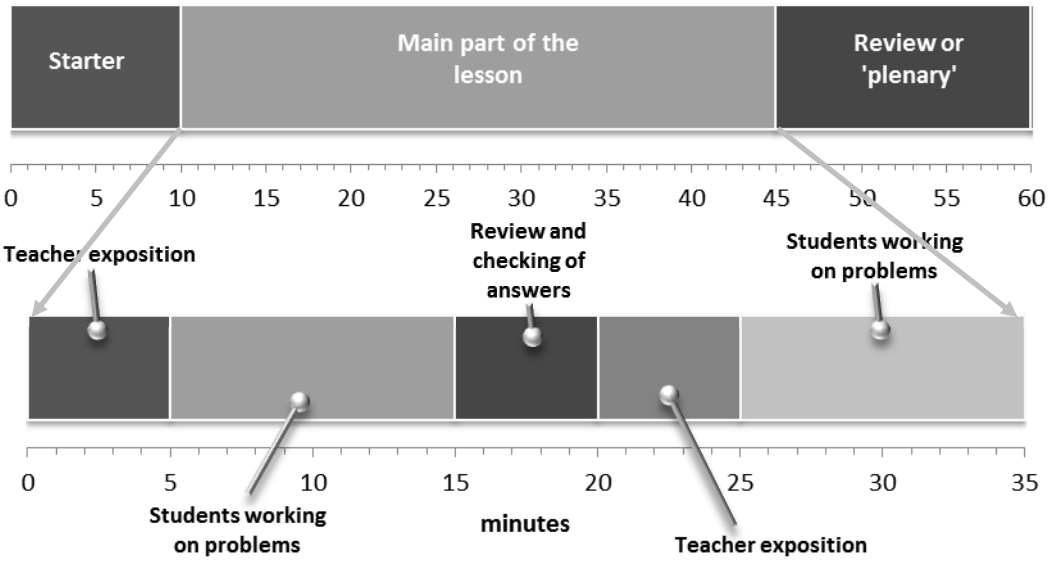

Figure 2. A traditional lesson structure with an expanded view of the main part of the lesson.

Summary and implications

We have argued here that lesson structure is a useful and reliable way of supporting the rapid-coding of lessons. Lesson structures represent a high level model of a lesson that can easily be communicated to teachers. This perhaps, explains how lesson structures appear to be retained through a number of generations of teachers. A lesson structure is a cultural artefact that is transmitted through generations of teachers. It would be both interesting and useful to explore this further.

However, in this paper we have focussed on how lesson structure can be identified and used. It appears that episodes—the sub-units of a lesson structure—can be easily and reliably identified. We also suggest that there are hallmark structural models for traditional lessons and different kinds of student-centred lessons. So in introducing an innovation through PD we can look at the extent to which the structure of teachers' lessons change.

More importantly, identifying the structure of a lesson can help with the analysis of a large numbers of lessons. While it would not be possible to transcribe and code whole lessons we can use the structure to identify elements or take samples across a number of lessons but in a systematic way.

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