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Student Teachers Learning to Plan Mathematics Lessons

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Most educational professionals would agree that planning is an essential component of teaching. Such planning, educational texts and reports often stress, must focus on the specifying of clear objectives and a clear lesson structure. As a result, a common framework used to introduce student teachers to the complexities of lesson planning is premised on starting *the planning process with specifying objectives. Yet there is considerable evidence that experienced teachers do not plan in this way. Their planning is likely to more idiosyncratic or they may plan in different ways depending on particular circumstances. The effect of this can be that the more skilful the planning, or the more it happens at unscheduled times, the more difficult it is for student teachers to understand how successful lesson planning is achieved. In this article we review the basis for introducing student teachers to lesson planning and examine some of the advantages and disadvantages of beginning with an emphasis on the explicit formulation of lesson objectives. We argue that while starting with objectives may help to focus student teachers on what pupils might learn during a particular lesson, there is a danger that it produces rigid plans that emphasise the more easily measurable parts of the mathematics curriculum at the expense of the more creative and spontaneous aspects of mathematical thinking.*

Introduction

Few would deny that effective lesson planning lies at the heart of successful teaching. Indeed, Clark and Yinger (1987 p84) refer to the pivotal role that planning plays in linking curriculum to instruction. Reflecting views about the crucial importance of clear and explicit planning for mathematics lessons, a report on mathematics teaching from the UK Office for Standards in Education suggests that "in the best schools, new targets are set for each [mathematics] lesson and planning is based on good records" (Ofsted 1995a p11). In contrast, the report claims that about 15% of mathematics lessons for 11-14 year olds are inadequately planned (compared with 10% of lessons for 14-16 year olds) with work that is not well-matched to the previous attainment of pupils. In primary schools, the report infers, the proportion of poorly planned mathematics lesson may be as high as 60%. In such cases, a "lack of clear objectives is closely linked to poor planning" (*ibid* p9).

This emphasis on setting out clear objectives is also evident in the UK framework for the inspection of schools (Ofsted 1995b p72). It is also the basis for the specification of subjects, particularly mathematics, within the UK National Curriculum.

For student teachers this requirement for an emphasis on clear lesson planning is demonstrated in the UK Teacher Training Agency definition of the standard required for the award of Qualified Teacher Status. These standards require that "those to be awarded Qualified Teacher Status must, when assessed, demonstrate that they

a) plan their teaching to achieve progression in pupils' learning through identifying clear teaching objectives and content, appropriate to the subject matter and the pupil being taught, and specifying how they will be taught and assessed…….
b) provide clear structures for lessons, and for sequences of lessons, in the short, medium and longer term, which maintain pace, motivation and challenge for pupils. …." (TTA 1997)

Significantly, however, it is also clear from the available evidence that planning is a complex and demanding task which involves teachers generally, and mathematics teachers in particular, in transforming and interpreting a significant range of knowledge (John 1993, 1994, Martin 1994). Given the demands that it places on experienced teachers, planning is undoubtedly one of the most demanding tasks for student and beginning teachers, linked as closely as it is to the equally demanding but often more overt issue of effective classroom management.

While acknowledging that teachers are involved in various levels of planning, including daily, weekly, termly, and yearly planning, in this article we concentrate on daily lesson plan construction because it is here that the student teacher is faced with putting their lesson intentions into action. We particularly wish to review how teachers are introduced to the complexities of lesson planning and examine some of the advantages and disadvantages of focusing on the explicit formulation of lesson objectives in the early stages of initial teacher education courses. We begin by considering some of the reasons for planning before reviewing the literature on how experienced teachers plan.

Why plan lessons?

Reys *et al* (1995) provide a useful summary of some of the well-established reasons for planning lessons. They suggest that planning:

- establishes definite goals and helps to ensure essential content will be included
- permits scheduling work in feasible units of time and in a sensible sequence.
- helps to ensure that a lesson begins interestingly, maintains a good pace throughout, and has a satisfying ending.
- aids in holding children's interest and attention.
- helps to avoid unnecessary repetition
- creates a feeling of confidence for the teacher

Perks and Prestage (1994 p 66-67), in considering planning from the perspective of student teachers, look rather wider than the usual reasons for highlighting planning. In addition to encouraging the (student) teacher to articulate what they think will happen in a given lesson and enabling aspects of the lesson to be rehearsed, they also argue that planning:

- makes the (student) teacher more likely to be receptive to the ideas of others
- can be a basis for discussion and evaluation
- can be a basis for negotiation
- provides a history of the (student) teacher's thinking

Such arguments underline the importance of planning, both in terms of successful teaching, and as a vehicle for student teacher development, but, in themselves, they do not go very far in providing a basis for how student teachers should be introduced to the complexities of lesson planning. Perhaps evidence of how experienced teachers plan lesson might provide some guidance and it is to that evidence that we turn in the next section.

How, where and when do experienced teachers plan and evaluate their lessons?

It seems that the lesson plans of successful teachers tend to be idiosyncratic. Research indicates that, because successful teachers are able to draw on a rich repertoire of standard lesson segments, their lesson plans tend to consist of idiosyncratic phrases or illustrations, or a

combination of both (for reviews see John 1991, 1993, Wragg 1995). These phrases or illustrations correspond to, and evoke, particular sections of a lesson. In constructing lessons, an experienced teacher is able to draw on a range of experiences and knowledge in an attempt to fit the anticipated and observed needs of a particular lesson or set of lessons.

What is more, the evidence suggests that successful teachers start with activities; that is, with the context, the content and the tasks being set. Objectives, in particular, are often hidden in the planning process and/or occur at various points within it, although they can, if necessary, be made more explicit. Wragg (1995), for instance, reports a research study showing that experienced teachers tend to have a mental outline of what they intend to do rather than a written plan. None of the experienced teachers in the study actually went as far as specifying objectives. This, Wragg suggests, is because experienced and successful teachers structure their lessons intuitively and spontaneously.

This evidence supports the view that for experienced teachers, in most instances, idiosyncratic lesson plans are entirely appropriate. There are times when a more explicit lesson plan may be necessary; for instance, when a new or seldom taught topic is scheduled, or if the work of the teacher is due for inspection. Full lesson plans can also be a useful basis for dialogue with student and beginning teachers. Yet, in the normal course of events, full lesson plans do not seem to be all that important, or, perhaps more accurately, full lesson plans would necessarily need to be rather complex and would be costly, in terms of time, to produce. Furthermore, given the flexibility to respond to pupil input demanded by experienced teachers, such plans may not even accurately reflect what took place during the actual lesson. As a result, it may be that the teacher's records of the lesson, in fact, shows what the pupils learned rather than any plan. All the more reason, it seems, not to produce elaborate written plans.

This absence of explicit objectives and the preference for a more fluid mode of planning poses a difficulty for student teachers and a dilemma for teacher educators. For student teachers it can be that the more skilful the planning or the more it happens at unscheduled times, the more difficult it is for the student teacher to understand how successful lesson planning is achieved. What is more, the requirement for student teachers to produce written plans may seem oddly at variance with the practice of established teachers. A case, perhaps, of doing what I say, rather doing what I do, which may create the impression that planning is something that is done only to pass an initial teacher education course.

For the teacher educator there is the dilemma of how to ensure that student teachers learn to create effective lessons. There is no disputing the importance of clear planning, it is how that is encouraged that is the issue, and whether particular approaches serve to promote or undermine effective mathematics teaching that is the concern of this article. Later in this article we will emphasise the importance of being guided by theories as to how mathematics teachers learn in the decisions we make over appropriate judgments about the design of teacher education courses, but for the moment we will turn to how student teachers are expected to plan lessons.

How are student teachers introduced to the complexities of lesson planning?

John (1993 p30) claims that "virtually all major guide books on curriculum and lesson planning begin with the importance of laying down at an early stage the educational and learning goals that will guide the lesson". This suggests that the common framework used to introduce student teachers to the complexities of lesson planning is based around the 'rational

planning model' first outlined by Tyler in 1949. This model asserts that planning a lesson or a sequence of lessons involves:

- specifying objectives
- specifying knowledge and skills
- selecting and sequencing learning activities
- evaluating the outcomes

In this model the specifying of objectives comes *before* the selecting of activities. This is in stark contrast to what we know of how experienced teachers plan their lessons. For them the objectives come out of the chosen tasks, rather than the objectives determining the tasks. This may well be an important distinction, and, as we shall suggest later, it may have significant consequences for mathematics teaching in particular.

The assertion that *starting* with objectives is the most common approach used with student teachers is supported by evidence from a range of popular texts for student and beginning teachers. For example, each of Capel *et al* (1995), Cohen *et al* (1996), Kyriacou (1991 and 1997), and Tolley *et al* (1996) contain advice about lesson planning, and each explicitly emphasises the requirement to consider learning objectives early in the process. This is despite the evidence that successful teachers, from all the relevant research studies carried out, do not start with objectives, preferring instead to retain a good deal of flexibility, and frequently starting their planning with thinking about pupil tasks.

To be fair, both Cohen *et al* (1996 p40-42) and also John (1993 p31-32) deal with some of the advantages and disadvantages of focusing on the explicit formulation of lesson objectives. The suggested advantages of specifying objectives include that they:

- are measurable
- are easily communicated
- help to clarify thinking and planning
- make assessment and evaluation clearer

Amongst the disadvantages are that specifying objectives:

- makes planning rigid
- inhibits opportunist learning
- trivialises learning
- encourages a technicist rather than creative view of teaching

The outcome of considering these advantages and disadvantages, for both Cohen *et al* and for John, is a reassertion of the importance of objectives; although in a considerably more circumspect way in John (1993).

Thus it seems that a range of influences will encourage student teachers to focus their lesson planning on specifying objectives. These influences include:

- teaching competencies as set down by Government for qualified teacher status (and, perhaps, frequently reflected in course objectives or assessment criteria for initial teacher education courses),
- educational texts aimed at student and beginning teachers
- official reports on teaching quality
- the basis for school inspection

- the framing of the national curriculum

Of course, it *may be* that such an explicit emphasis on the specifying of objectives, and, sometimes implicitly, that such specification comes early in the planning process is precisely the proper thing to emphasise in initial teacher education.

Yet John argues elsewhere (John 1991 p317) that teacher educators should begin to question an overly objectives-based approach to lesson planning for their student teachers because such an approach "bears very little relationship to the thinking and actions of student teachers in the context of the classroom". Instead, John suggests that an approach is developed that promotes planning as both "dialogical and problem solving in conception", one that is more of an on-going learning process that goes beyond the period of initial teacher education. In the next section we summarise some issues that we suggest need to be considered when introducing mathematics student teachers to lesson planning, beginning with an outline of some of the evidence regarding student teachers in the process of learning to plan mathematics lessons.

Issues related to introducing mathematics student teachers to lesson planning

how student teachers plan mathematics lessons

John (1991) reviews previous research on student teachers which suggests that they enter courses of initial teacher education with a set of beliefs about teaching that clearly influences a great deal of their learning. Other major sources of influence on them can be the pupils they teach and the experienced tutors and teachers with which they work.

The three mathematics student teachers that John studied showed a remarkable degree of homogeneity, with their perceptions of mathematics having a strong influence on their ideas about planning. They all saw mathematics as a predominantly hierarchical subject and, given their positive experiences of mathematics as pupils, were heavily influenced by their own vision of how they should plan and teach the subject. As a result they planned lessons consisting of a pattern of exposition, examples and practice and either used or rejected the guidance offered by tutors and mentors based on their own preference for this particular vision of mathematics teaching.

Given the underdeveloped nature of the research base for mathematics teacher education, this is a useful study of mathematics student teachers as it indicates the strength of the underlying perspectives of student teachers and how little these may be challenged during a short course of initial teacher education. On the other hand, if such perspectives are to be successfully challenged then it is likely that an emphasis on objectives within lesson planning will *not* be the vehicle for doing so. In fact such an emphasis on objectives may well be likely to *strengthen* such a perspective.

All this indicates that, "it is not enough to specify necessary courses or content or competencies for teacher education programs. We must be guided by theories as to how mathematics teachers learn and how teacher education can effectively support these learning processes" (Simon 1994 p88). Such a theoretical framework, once fully established, may be able to guide mathematics teacher educators in ways, for example, of engaging student teachers creatively in the process of planning lessons.

a framework for how mathematics teachers learn to teach mathematics

In a striking article, Simon (1994) outlines a framework which, he suggests, may go some way towards describing the process of becoming a mathematics teacher. The framework consists of six related cycles which Simon has found useful in characterising important aspects of mathematics teacher learning (the framework is not intended to include all aspects of teacher learning nor all their interconnections). The six cycles are:

1. learning mathematics
2. developing knowledge about mathematics learning
3. developing theories of mathematics learning
4. understanding students' learning
5. instructional planning
6. teaching

Thus, in this model, learning to teach mathematics is viewed as a developmental process where different domains of knowledge build on each other, not in a linear fashion as perhaps indicated by the above list, but cyclically with numerous interconnections. For example, learning cycle five, which focuses on learning about the planning of mathematics teaching, serves as an application phase for each of the first four learning cycles. In this particular cycle, student teachers call upon their knowledge of mathematics, their theories of how mathematics is learned, and their understanding of students' mathematical development. Yet, as Simon stresses, student teacher learning "may be occurring at many levels of the six cycles simultaneously with very complex patterns of interaction among the different levels of learning" (*ibid* p87)

Such a model of student teacher learning may well fit with John's suggestion, outlined above, of learning to plan lessons as an on-going process. It suggests that a useful avenue to explore may be a significant emphasis on cycles 1 to 3 in initial teacher education, even during a one year post-graduate course. It may well be that focusing sufficient attention on these earlier cycles will more successfully challenge mathematics student teachers underlying perceptions of mathematics teaching.

working with mentors

Such an on-going, developmental, model also indicates the need to work closely with mentors in schools. This is particularly the case with one-year graduate courses, given that student teachers on such a course spend two thirds of their time in schools. In discussing these issues with mentors from our partner schools we developed the following list of suggestions for mentors:

Mentors:

- talk about the value and importance of planning
- set an example (and occasionally perhaps a counter example?)
- focus attention on planned/unplanned aspects of a lesson
- talk about their own planning
- show how there are differences between student teacher planning and the planning carried out by experienced teachers
- ask students to focus on the implementation of their lessons and how they went in practice
- involve student teachers when teachers are reviewing schemes of work

While these might be useful pointers, much of the above indicates that some additional well-focused empirical research on the issue of mathematics student teacher planning is necessary

to offset some of the excesses of the overtly competency-based approach to initial teacher education currently being promoted in the UK. Such empirical work should also strengthen the theoretical framework.

Concluding comments

In this article we have reviewed the basis for introducing student teachers to lesson planning and examined some of the advantages and disadvantages of beginning with an emphasis on the explicit formulation of lesson objectives. While we certainly would not wish to distract attention away from the need for student teachers to devote much of their attention and energy to effective lesson planning, we are concerned that while starting with objectives may help to focus student teachers on what pupils might learn during a particular lesson, there is a danger that it produces rigid plans that emphasise the more easily measurable parts of the mathematics curriculum at the expense of the more creative and spontaneous aspects of mathematical thinking.

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