An investigative lesson with dynamic geometry: A case study of key structuring features of technology integration in classroom practice

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Structuring features of classroom practice

- Key constructs distilled from synthesis of two literatures
- Recent studies of technology use in school mathematics
- Earlier studies of situated teacher expertise

(Ruthven, 2007)
An investigative lesson with dynamic geometry

- Case nominated by teacher as an example of successful practice.
- Took place over two 45-minute sessions on consecutive days.
- Involved a Year 7 class of students (aged 11-12) in first year of secondary education.
- Planned as extension from previous work on construction using manual instruments.
- “We moved it around and it wasn’t the centre of the triangle, sometimes it was inside the triangle and sometimes outside…”
• Making use of computer-based tools and resources in teaching is often associated with changes in teaching room, physical layout, class organisation, and classroom routines. (Jenson & Rose, 2006)

• The concept of working environment focuses on the physical surroundings in which lessons are conducted, and the associated general infrastructure and organisation.

• With the use of new technologies, routines which help lessons to start, proceed and close in a timely and purposeful manner often have to be adapted. In particular, organisational routines need to be established through which equipment is made ready and resources accessed for use, and through which results are recorded and shared.
• Starting sessions in the teacher’s own classroom:
  – avoided disruption to the established routines underpinning the smooth launch of lessons;
  – provided an environment more conducive to sustaining effective communication during whole-class activity and to maintaining the attention of students, “without the distraction of computers in front of each of them”.

• Then in the computer suite, new routines were being introduced for opening and closing sessions:
  – opening a workstation, including logging on to the school network, using shortcuts to access resources;
  – naming and saving files, and printing out work economically and efficiently via the shared printer: “I’d rather have a small amount that you understand well than loads of pages that you haven’t even read.”
Although new tools and materials are often represented as displacing old, it is more common to find some form of ‘double instrumentation’ involving both old and new.

The concept of resource system focuses on the combined functioning of all the mathematically-related tools and materials in classroom use, particularly in terms of their compatibility and coherence.

Thus resource is used here to refer to some (physical or virtual) artefact which has either been designed specifically for curricular purposes, or been the subject of educational appropriation for such purposes.

The use of system reflects the challenge which teachers face in combining what otherwise would be merely a collection of resources to function in a co-ordinated way aligned with their teaching goals. (Amarel, 1983)
• The teacher saw work with dynamic geometry as complementing established construction by hand, by strengthening attention to geometric properties: “Geometer’s Sketchpad forces you to use the geometry and know the actual properties that you can explore.”

• Nevertheless, he saw computer techniques as lacking congruence with manual, involving different methods and having distinct functions: “I don’t think it’s a way of teaching constructions, it’s a way of exploring the geometry.”

• Likewise, some computer affordances were less welcome, requiring sociomathematical norms to be established for appropriate use of presentational devices: “I want them to slightly adjust the font and change the colours a little bit, to emphasise the maths, not to make it just look pretty.”
The concept of activity format focuses on the templates for action and interaction which frame the contributions of teacher and students to a particular type of lesson segment. (Burns & Anderson, 1987; Burns & Lash, 1986)

The crafting of lessons around familiar activity formats and their supporting classroom routines helps to make them flow smoothly in a focused, predictable and fluid way permitting the creation of prototypical activity structures or activity cycles. (Leinhardt, Weidman & Hammond, 1987)

The development of technology use in mathematics lessons is often associated with changes in activity formats (notably to incorporate the teacher-student-machine triad) and activity structures (notably towards more exploratory and discursive approaches) (Monaghan, 2004; Trouche, 2005)
The teacher was still trying to find a satisfactory organisation of student work at computers: “I’m not sure really how to combine working with computers with discussing… [without] taking away the opportunity for everybody to explore things for themselves”

However, the teacher noted ways in which use of the software already supported his interactions with students:
- helping students to identify and resolve bugs in their dynamic geometry constructions: “They were saying: ‘Oh, something’s wrong.’ So I was: ‘Which line is perpendicular to that one?’”
- helping students to express themselves clearly by discussing revision of editable textbox summaries: “They could actually then think about what they were writing, how they describe.”
The concept of *curriculum script* focuses on a loosely ordered model of relevant goals and actions which guides the teaching of a topic, interweaving ideas to be developed, tasks to be undertaken, representations to be employed, and difficulties to be anticipated. (Leinhardt, Putnam, Stein & Baxter, 1991)

Teachers often talk about their use of new technologies in terms which appear to involve the adaptation and extension of established curriculum scripts.

However, when teachers participate in development projects, they experience pressure (often self-administered) to abandon their existing curriculum script in pursuit of more ‘innovative’ approaches. (Monaghan, 2004)
The teacher’s curriculum script was evolving to:

– exploit difficulties that students encounter in constructing a dynamic figure to reinforce the mathematical focus: “Discussions I had with them emphasised which line is perpendicular to that edge.”

– incorporate strategies for helping students to appreciate the geometrical significance of features of the dynamic figure: “When I talked about meeting at a point, they were able to move it around.”

– develop more precise characterisation of new dynamic mathematical relations: “I was just expecting them to say it was on the line… Then I saw it was exactly on that centre point.”
The concept of *time economy* (Assude, 2005) focuses on how teachers manage the ‘rate’ at which the physical time available for classroom activity is converted into a ‘didactic time’ measured in terms of the advance of knowledge.

Many studies report teachers’ concerns about the time costs of integrating technology into the curriculum.

In particular, the ‘double instrumentation’ in which old and new tools are used alongside one another typically gives rise to additional time cost rather than the substitution and reduction implied by talk of a ‘time bonus’.

A critical issue is what teachers perceive as the return in terms of recognised mathematical learning from investing in students using new tools.
Time economy

• A basic consideration of physical time was the proximity of the new computer suite to the normal classroom: “If I was upstairs… it would be much harder. It would take five minutes to move down.”

• Because he saw working with the software as engaging students in disciplined interaction with a geometric system, this teacher was willing to invest time in familiarising students with it: “I always like to start with a blank page and actually put it together in front of the students so they can see where it’s coming from.”

• A more fundamental feature was that this teacher measured didactic time in terms of progression towards student learning rather than pace in covering a curriculum: “At the moment, I suspect they’ve got vague notions of what they’ve learned but nothing concrete in their heads.”
Concluding thoughts

- This framework seeks to make certain crucial – but often overlooked – aspects of incorporating new technologies into classroom practice visible and analysable.
- By providing a system of constructs closer to the lived world of teacher experience and classroom practice, this framework may fulfil an important mediating function, allowing insights from more decontextualised theories to be translated into classroom action, and serving to draw attention to practical issues neglected in such theories.
- Although only employing a dataset conveniently available from earlier fieldwork, the case analysis starts to illuminate the combined influence of the key structuring features.
- The framework needs to be subjected to fuller testing and corresponding refinement through further studies in which both data collection and analysis are guided by it.