Interactive Whiteboards and all that Jazz: Analysing Classroom Activity with Interactive Technologies

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The term 'orchestration', has been used to describe the teacher's role in activity settings incorporating interactive technologies. This musical analogy suggests pre-planned manipulation of events to generate 'performance' leading to learning. However, in two recent projects we have observed how effective teaching and learning is often based on serendipity and improvisation – characteristics more often associated with jazz. This paper explores how a jazz analogy can be useful when analysing classrooms in which serendipitous events were exploited and performances were improvised

During the last decade, interactive whole-class technologies (IWCTs) such as interactive whiteboards (IWBs) have become increasingly prevalent in classrooms. In the course of two funded studies (see Kennewell et al., 2009a; 2009b), a framework of classroom use of ICT was developed (Tanner et al, 2005; Beauchamp & Kennewell, 2010) which examined the orchestration of activity settings (Tharp & Gallimore, 1988). Emerging from this work was the need to take account of serendipity in learning situations. It was clear from our observations that in effective learning environments, teachers and learners often moved outside the constraints of pre-determined orchestration and began to improvise.

Background

Teachers regard IWBs as valuable for gaining and maintaining the attention of students and find them useful for collating resources for instant selection and display during the course of lesson activity (Smith et al., 2005). However, the extent to which the interactive features of IWBs are valued is less clear. Beauchamp and Kennewell (2008) suggested that the key affordance for action during learning tasks is the immediate, contingent feedback to students that is characterised as 'interactivity'. The term 'interactive' is used in different ways in the literature concerning whole-class teaching and we distinguish technical interactivity (physical interaction with the device) and pedagogic interactivity (interaction between students and others in the classroom designed to bring about learning) (Smith et al., 2005). It is pedagogic interactivity which appears to be most significant for effective learning (Tanner et al., 2005; Kennewell et al., 2008).

The impact of IWCTs on learning is dependent on the mediating role of the teacher (Hennessy et al., 2007), and it is pedagogic rather than technical interactivity that is usually critical. When technical interactivity is prioritised over pedagogic purpose, some relatively mundane activities may become over-valued (Moss et al., 2007). Sadly, in UK schools interactive pedagogy is often quite limited in scope. Lessons with IWBs are more often dominated by whole-class teaching than those without and demonstrate a more rapid rate of interaction between teacher and pupils ('pace'), albeit at a rather superficial level, with

pupils generally offering short responses rather than dialogic exchanges (Smith et al., 2006).

Pedagogic interactivity in whole-class teaching may be classified according to the degree of control allowed to the pupils over the trajectory of the lesson (Tanner et al., 2005). This ranges from a 'lecture' approach with a high level of teacher control at one end of the scale through 'funnelling questioning', 'probing questioning' and 'focusing and uptake questioning' to 'collective reflection', at the other end. This scale has been used to analyse teaching episodes with and without the use of ICT, and there is some evidence that shifting the nature of pedagogical interactivity towards greater student influence may be more important in improving the quality of learning (Kennewell et al., 2009a).

There is evidence that with effective teacher mediation IWCTs can support more dialogic interaction and 'the most effective use of IWBs seems... likely to involve striking a balance between providing a clear structure for a well-resourced lesson and retaining the capacity for more spontaneous or provisional adaptation of the lesson as it proceeds' (Gillen et al., 2007, p.254). Hennessy et al., (2007 p.298) claim that 'the strength of the IWB lies in its support for shared cognition, especially articulation, collective evaluation and reworking of pupils' own ideas, and co-construction of new knowledge'.

In analysing teacher mediation of ICT and other resources in the classroom, the idea of 'orchestration' is helpful (Kennewell et al., 2008). This construct extends the idea of 'scaffolding' and concerns the planned and responsive manipulation by the teacher of the features of the classroom setting (including students, resources, and less tangible features such as culture and ethos) to support the goal-related actions carried out by students and the development of common or collective knowledge.

When the culture of the classroom and the features of the task and the technology support it, pupils may sometimes orchestrate features of the setting for themselves. We have observed this less classical form of orchestration in some effective learning contexts.

Extending the musical analogy

In music, orchestration is a systematic, [pre]considered organisation of instruments or voices. (Scholes, 1980) This includes deciding how they will be combined and sequenced in performance. In the classroom analogy this could be equated to how the teacher chooses to combine and sequence different features of the setting and student or teacher voices.

Classical orchestration normally leads to choices being written down in a score which is largely fixed, although the conductor may interpret this in different ways, just as teachers can interpret a lesson plan in practice. In schools, the widespread use of ICT for pre-prepared slide presentations reinforces the musical analogy of a fixed `score' for a lesson (Beauchamp & Parkinson, 2005). In the classical genre, the trajectory of the performance is under the control of the conductor. Consequently, the success of performance (lesson) is normally attributed to the conductor (teacher) and not to the players (learners).

When teachers first began to experiment with IWCTs, their practices often followed this classical analogy (Beauchamp & Parkinson, 2005; Smith et al., 2006). However, classical orchestration does not model more flexible pedagogical approaches, which use IWCTs to support more spontaneous and dialogical interactions with pupils.

We have observed (Kennewell et al., 2009a) many effective lessons in which teachers encourage pupils to express their own ideas for public discussion and contingent response, in an approach described by Alexander (2004) as 'dialogic' teaching. IWBs have often been used to support this process by providing a public site for the co-construction of knowledge which can be placed under the control of pupils who are taking the lead for the

moment. This style of orchestration is more characteristic of jazz in which the musician's unplanned improvisations in response to stimuli from other players mirrors the teacher's ability to respond in the moment to spontaneous ideas from pupils who have taken the lead.

Improvisation

Improvisation may be defined as 'the conception of action as it unfolds, drawing on available cognitive, affective, social and material resources' (Kamoche et al. 2003 p.2025) Two forms of improvisation characterised by Kernfield (1995) seem helpful in analysing classroom activity. 'Paraphrase improvisation' is characterised by the 'ornamentation of an existing theme' whilst 'formulaic improvisation' by the 'artful weaving of formulas'. This latter type of improvisation is helpful when analysing less classical forms as it is dynamic and responsive. In the classroom, we refer to this as 'dynamic orchestration', in which planned activities are rearranged and redesigned during the lesson in response to matters that arise, whereas paraphrase improvisation involves ideas on subject matter being elicited and developed by pupils in a more limited sense within a planned lesson structure.

For example, a class of 13 to 14-year-olds was taught about reflection using software from NGfL Cymru (http://www.ngfl-cymru.org.uk). Shapes and mirror lines were drawn and dragged on a grid. Reflections in lines and construction lines were available options.

Initially, a triangle was displayed on the IWB. Pairs of pupils discussed the position of a reflection in x=2. A volunteer was invited to the board to draw the reflected triangle in approximately the correct position using IWB board tools. He was then asked to justify his answer. He struggled to explain and the teacher asked contingent, probing questions to clarify how he had visualised the reflection. Members of the class were invited to evaluate his solution and justify their claims. Their suggestions included counting diagonal distances, counting squares in the x and y directions, or drawing construction lines.

Pupils were invited to the board to demonstrate their ideas. The teacher asked probing questions about their reasoning and focussed attention on salient features and limitations of strategies. Finally, the software confirmed the position of the reflection under the lines drawn by pupils and the construction lines were inserted.

The teaching had incorporated a degree of improvisation as the teacher responded to the pupils' unpredictable and varied responses. The context was very structured, however, and the degree of improvisation afforded was limited by the task and the context.

The pattern of interaction was repeated with more examples before a paper and pencil exercise based on a worksheet of similar, but progressively more difficult, tasks. The final, most challenging, example was a polygon crossing over a mirror line at 45° to the axes. Towards the end of the lesson, several pairs of pupils had partial or incorrect solutions to this problem. Others had become "stuck" and unsure of how to proceed.

The diagram was displayed on the IWB for a plenary discussion. Pupils volunteered ideas but no-one gave an accurate answer immediately. Class discussion followed, with pupils arguing their own cases. The teacher questioned to help pupils clarify their thoughts, but suspended evaluation of suggestions. Eventually two pupils came to the board together and with the help of suggestions from the class managed to construct an accurate reflection.

Significant improvisation was required from pupils, albeit within an environment structured by the task and the technology. Extensive modifications were made to the process in a complex, but structured conversation between multiple voices which was dialogic in character. Pupils made exploratory and tentative suggestions, some of which

were taken up and made the focus of discussion by the teacher. Other comments by pupils were cumulative in character as the board became a space for collective thinking.

Finally, the teacher invited the class to reflect on what they had learned about strategies for constructing reflections, drawing out the weakness of purely intuitive approaches in more complex questions. The teacher orchestrated contributions from a range of voices, in a flexible manner to summarise the learning that had occurred. This demanded improvisation from pupils as well as the teacher in a cumulative, reflective dialogue.

Jazz and Pedagogical Approaches

Jazz musicians face a challenge in balancing the risk of failure with the creative tension involved in embracing mistakes and using them to form creative new pathways for action. This parallels research contrasting positive teaching approaches, that are apparently safer in their production of clear arguments, with those based on cognitive conflict in which the production of erroneous conceptions are actively sought. The relative success of conflict based approaches demonstrates the value of exposing such errors (see, for example, Bell, 1993; Muller et al, 2008). It could be argued that mistakes are more likely in a minimal structure, rather than a fully notated classical score. However, such 'mistakes' can also provide the catalyst for creativity as new and unexpected situations present themselves.

Neyland (2004) suggested an interdependent set of characteristics of the jazz metaphor: (i) complexity (not complicatedness), (ii) an optimally minimal structure, (iii) the primacy of creative and spontaneous improvisation, (iv) challenging ('playing outside') established structures, (v) pursuit of ideals, and (vi) ethical know-how. The last of these includes the notion of 'effortless mastery', which is a mode of learning. This process is quite different from repetitive practice of techniques, and leads to effortless (but not habitual) performance in which new ideas are created, seemingly independent of conscious effort.

Players in the classroom have a range of instruments at their disposal – ICT as well as the more traditional ones such as ones of voice, pen/paper, etc. Individual skill levels with the instruments varies and the role of the teacher is to draw the best from the players by allowing varying degrees of freedom and structure within the features of the environment. Loosened structure and increased freedom are characteristic of a move towards a more improvisatory use of ICT. This is analogous to the jazz musician for whom the musical score is only a starting point or guide and not an end in itself. In the jazz genre, the lesson plan and resources may provide only a loose framework for performance. This contrasts strongly with the current fashion in official guidance for tightly pre-determined objectives. One of the challenges for teaching in the jazz genre is the ability to make decisions in the moment to provide the contingent responses which are characteristic of improvisation.

Another feature of the jazz genre is that there may be no apparent conductor, although in reality one of the players is likely to be leading. Change of control may be signalled by offering the lead to another player and becoming one of the band. Similarly, teachers may temporarily hand over the lead to pupils and this is often signalled by relinquishing their position at the front of the class - 'standing away' from the board (Lewin et al., 2008 p.297).

An example of improvisation and change of lead was seen during a lesson with 10 year old pupils who had undertaken a practical investigation to find out the total scores obtained when rolling two dice 50 times. The scores obtained by each group were collated on the IWB to find the overall frequency with which each total had occurred. As the totals were displayed some pupils spontaneously began to suggest reasons for the emerging patterns.

Pupil: Sir, 7 will be the most likely total as you can make 7 in lots of ways, but a 2 you can only get in 1 way

(Although the teacher had not planned to do this analysis until the subsequent lesson he improvised in a contingent response to these suggestions and invited one pupil to explain)

Teacher: Go on, please explain. I'm interested in your ideas. Can you use the board to show us what you mean? Come on, you take over. I'll sit in your seat.

The pupil then moved to the board and took the lead, addressing the class who listened attentively whilst she repeated her reasoning and started to write out some number pairs:

$$2 = 1 + 1$$
but
$$7 = 4 + 3$$
$$7 = 1 + 6 \ldots$$

After she finished her explanation she looked to the teacher for comment and he returned to the front and took back the lead. The pupil had been improvising, as her contribution was unplanned. The teacher continued to improvise as he asked the class for comments and invited pupils to the board to explain how other scores could be generated.

In this short performance, all the players (learners and teacher) were listening to and responding to what others were playing (contingent response). On occasions there were solos (learners at the front) while others were content to maintain their place in the band – although they still had to be listening and responding to the soloist.

The Goal of Lesson Activity Subversive Improvisation

When musicians are playing jazz together, they are likely to share an understanding of their aims for the performance. However, when pupils perform classroom activities, they do not always share the same goals as their teachers. There are often two sets of goals: those concerned with products and those concerned with the learning process. Pupils are often focused on task completion and have goals associated with completing an exercise or a product, to gaining marks, rather than the teacher's learning goals (Kennewell et al., 2008).

The following episode is taken from a lesson with 32 13-year-old pupils. A circus of three activities was to be studied in turn by each of three groups of pupils. Each activity was to be completed in approximately 15 minutes. We focus here on one of the activities – sequences.

The lesson had started with the teacher demonstrating all three of the activities to the whole class and leaving the sequences activity on the IWB for the first group of 11 pupils to attempt. The software gave sequences of numbers that were connected by an unknown, two-part, linear function such $2n + 3$

$$5 \quad 7 \quad 9 \quad 11 \quad 13$$

Two "sliders" underneath the sequence allowed pupils to adjust the coefficients of the two terms in the sequence in an expression that appeared in a box marked "answer". When an expression was entered, the sequence for that expression appeared underneath the original sequence for comparison.

	5	7	9	11	13		Answer
	5	8	11	14	17		3n + 2

-5	-4	-3	-2	-1	0	1	2	3 ⇧	4	5
-5	-4	-3	-2	-1	0	1	2 ⇧	3	4	5

Pupils were told to copy down the sequences and use any method they wished to find the expression. He showed them how to use the method of differences if they could not spot it by inspection. The first person to calculate the sequence would then take the pen and move the sliders to demonstrate that their expression gave the required sequence.

In a interview, the teacher said that he wanted them to be competitive, racing to be the first to finish and get the pen. He hoped that this would motivate them to work quickly.

When the pupils worked on the task during the "circus" phase of the lesson, they were competitive and motivated to be the one to enter the data at the IWB. They tried to work as fast as they could and some quickly realised that they could subvert the process and generate the solution without completing the calculation. Two boys realised early on that they could calculate the difference between two terms on the way to the board, set the first slider to the difference and then slide the second slider until the numbers matched, without ever calculating the expression for themselves.

These pupils had two goals: to be the pen holder and to construct the product as briefed – large numbers of sequences and expressions, confirmed as correct by the IWB. Unfortunately, this focus on product rather than learning had led to an improvisation that avoided some of the mathematics. The solution provided by the board was authoritative and classical in character, with some pupils doing little more than watching and copying and few, if any, thinking mathematically.

In this case, the features of ICT afforded a degree of improvisation, which was effective in meeting the pupils' success criteria without meeting the teacher's expectations of learning from the activity. Whilst this phenomenon is not a novel one, and may not be directly caused by ICT, it seems that there is greater potential for subversion because of the ease with which students can operate powerful tools. This mastery can also be harnessed in the cause of learning goals, of course.

For example, a mathematics class was taken to a computer room to use Autograph to explore reflections on individual PCs. Worksheets with polygons drawn on graph paper demanded the construction of a mirror line such as y=x, y=2x or y=-x, followed by the construction of a reflected image. Pupils were then asked to work in small groups to check their answers by constructing the shapes in autograph and reflecting in their mirror line.

At this stage, interaction with the affordances of the ICT was largely under the control of the pupils and their discussions developed a more dialogic character as they sought to explain any discrepancies between their answers and those generated by Autograph.

During this phase, many pupils made errors in plotting points and /or selecting the correct mirror lines. This resulted in unexpected reflections being generated by the software. The errors exposed in the interaction with the technology often challenged pupils to reconsider their ideas through dialogue with their partners, experimentation within the

software and/or discussion with the teacher. This more dialogic tone was developed further in the lesson plenary.

Several pupils had also seized the opportunity to subvert the set task and to use the affordances of the software to create their own shapes and reflection patterns, often creating dynamic and attractive symmetrical patterns. Unlike the pupils described in the previous sequence, however, the intention of these pupils was not to get to the right answer, but to play, and in so doing, they improvised their own mathematical work. The affordances of the software constrained them towards patterns which were mathematical in character, many of which offered opportunities for further learning.

Although the pupils tried to hide this play from their teacher by switching screens when she was nearby, eventually she noticed this off task behaviour. Instead of admonishing the pupils, she decided to take advantage of this spontaneous performance and asked them to present some of their designs to the rest of the class. Discussion of the construction of the designs provided an opportunity for collective reflection about some of the key strategies being taught in the lesson. The improvisation of the subverters resulted in a loosening of control and a move to a more improvisatory format in which the pupils assumed a degree of 'functional anarchy' and offered a performance of their own ideas.

In this plenary, the teacher was orchestrating a range of voices in an emergent and spontaneous, mutually constructed conversation that linked mathematical ideas with the aesthetics of art and design. Perhaps most importantly, it was pleasurable and exposed the joy of mathematics. The pupils' spontaneous improvisations had led to a performance with some of the characteristics of effortless mastery (Neyland, 2004).

Conclusion

We have often found the analogy of orchestration to be helpful when analysing the teacher's role in manipulating the features of classroom settings to generate activity or performance leading to learning. We suggest here that this can range from a highly controlled and pre-planned 'classical' style of orchestration to a range of more improvisatory orchestrations, more characteristic of the jazz genre. In our research we have observed effective teaching that has incorporated a range of genres within one lesson.

We suggest that a purely classical view of orchestration fails to recognise the extent to which effective teaching and learning makes use of serendipity and improvisation – characteristics more often associated with jazz. IWCTs have affordances which may be used to establish conditions under which more jazz like performances are likely to occur, offering opportunities for more creative, improvised teaching and learning. The dynamic and contingent properties of ICT can facilitate the exploration of ideas and improvisation by both pupils and teachers within and beyond the set task. The use of IWCTs provides easier sharing of ideas with the whole class. Moreover, the dynamic properties of ICT allow demonstration of the thinking process and not just the finished product.

Mathematics lessons within the UK often emphasise the reproduction of standard procedures, leading to a classical orchestration with rigid and instrumental lesson objectives. We would like to encourage more jazz like performances involving spontaneous improvisation and the critical application of learning to novel contexts. It may be that until this emphasis is changed, pupils will be largely restricted to playing someone else's tunes.

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