Appendix 1. T-MEDIA Teacher Interview 1 Questions

1. How many pupils in the class and what ability level are they?

2. What are your aims for this module and what do you want the pupils to learn?

3. How does it fit in with other work they have done / will be doing and with the curriculum?

4. How was this module developed and by whom?

5. What forms of technology do you expect to use, and how?

   How much involvement will the pupils have in the activities?

6. How familiar are the pupils with the technology?

7. What other resources will be used?

8. How will the classroom be organised? Will pupils work together on joint tasks some of the time?

9. How do you expect use of the technology to facilitate pupil learning?

10. What are the issues you will be considering in planning/preparing for the lessons?

11. Is there any preparation needed to tailor the lessons for this particular pupil group?

12. What plans are there for assessing learning during or after this module?

Appendix 2. T-MEDIA Teacher Interview 2 Prompts

1.   **Your thoughts while preparing the lesson**
What you wanted the pupils to learn
How you expected use of the technology to help pupil learning

2.   **Your thoughts looking back on the lesson**
How well pupils learned what you wanted.
How well the technology helped pupil learning

3.   **Further thoughts looking back over the whole lesson**
At each stage of the lesson, the important things that you were giving attention to, picking up on, and doing

4.   **Your thoughts about successful learning of [subject] in the lesson**
One or two examples of successful learning of [subject] by pupils where use of the technology was involved
What you did (or had already done) to help make that learning successful

5.   **Your thoughts about key actions in making use of the technology successful**
The key things that you did in preparing for the lesson to make use of the technology successful
The key things that you did during the lesson itself to make use of the technology successful

6.   **Your strategies for facilitating pupil participation**
Any actions that you took to facilitate pupil participation
How much pupils participated

7.   **Your thoughts about key actions during the previous lesson(s) that were videoed**
The key things that you did in preparing for the lesson(s) to make use of the technology successful
The key things that you did during the lessons themselves to make use of the technology successful

Any modifications you may have made to the lessons

Appendix 3. T-MEDIA Teacher Interview 3 Prompts

1. **Your thoughts while preparing the lesson**
   What you wanted the pupils to learn
   How you expected use of technology to help pupil learning

2. **Your thoughts looking back on the lesson**
   How well pupils learned what you wanted.
   How well the technology helped pupil learning

3. **Further thoughts looking back over the whole lesson**
   At each stage of the lesson, the important things that you were giving attention to, picking up on, and doing

4. **Your thoughts about successful learning of [subject] in the lesson**
   One or two examples of successful learning of [subject] by pupils where use of technology was involved
   What you did (or had already done) to help make that learning successful

5. **Your thoughts about key actions in making use of technology successful**
   The key things that you did in preparing for the lesson to make the use of technology successful
   The key things that you did during the lesson itself to make the use of technology successful

6. **Your strategies for facilitating pupil participation**
   Any actions that you took to facilitate pupil participation

   How well pupils responded

7. **Your thoughts about key actions during the lesson(s) that were videoed since the last interview**
   The key things that you did in preparing for the lesson(s) to make use of the technology successful
   The key things that you did during the lessons themselves to make use of the technology successful

8. **Your thoughts about pupil learning over the whole lesson sequence**
   How well pupils learned what you wanted
   How well the technology helped pupil learning
   How independently the pupils worked during the course of this lesson sequence

9. **Your thoughts about modifying the lessons**
   How you may have already modified this type of lesson in the light of your experience

   How you might modify the lessons in future

Appendix 4. T-MEDIA Follow-up Teacher Interview Prompts

Since our video review meetings,

1. Have you worked with [teacher/colleague] – or discussed the research with him/her any further?

2. Do you think your involvement with T-MEDIA has impacted on your thinking and practice in any way? If so, how? Can you give examples?

    a. Have you adopted any aspect/s of practice you saw modelled by T in the videos?

    b. Are there things that you would like to put into practice, but haven't yet? What are these? And what are the barriers?

3. Have you taught [the topic that was videoed] ? If so, to what year / group?

    a. Has your approach altered in any way since the last time you taught this topic? If so, how? Can you give examples?

    b. Why did you make the/se change/s?

    c. What is your evaluation of their success?

    d. What, if any, has been the feedback from pupils?

4. If you have been using an IWB, have you modified your approach in any way? If so, how? Can you give examples?

    a. Why did you make the/se change/s?

    b. What is your evaluation of their success?

    c. What, if any, has been the feedback from pupils?

5. Are you aware of any way in which your involvement with the T-MEDIA project may have had a subsequent, wider impact within the school / department (eg influence on policy / practice)? If so, could you give details.

6. Have there been any changes in policy / practice (national, whole school, or departmental) that have influenced or affected:

    a. your teaching generally?

    b. your teaching of the [videoed] topic?

    c. your use of IWB / technology resources?

    d. colleagues' use of IWBs / technology resources?

7. Reviewing your involvement with T-MEDIA research so far, what have been the most useful aspects?

8. Reviewing your involvement with T-MEDIA research so far, what have you found the most challenging or difficult aspects?

9. Can you comment upon your experience of the ***collaborative*** aspects of the research (eg working with a school colleague and university researchers, subject specialist input etc)? This could include:

    a. How you felt about working in this way (how the different participants' contributions were made and exploited, how equitable the collaboration was, etc.)

    b. How the collaborative process might be improved

10. Can you say how easy or difficult it was to grapple with the notions and language of socio-cultural theory when these were introduced?

    a. What, if anything, helped you to understand these better?

    b. How well did they fit with your own ideas?

    c. Did they influence your thinking or understanding of practice in any way(s) at the time? (which concepts in particular?)

    d. What about since then?

    e. How did you find the process of developing the coding scheme? (Did we reflect everyone's ideas in the codes and in the more global cross-lesson themes?)

11. Any other comments?

12. How were you introduced to the IWB? If you received training, who provided it and was it pedagogically or technically focused, or both?

Extra questions for filmed teacher:

1. Can you comment on whether and how the collaborative research process helped you to make the thinking behind your practice explicit?

    a. How easy or difficult was it to express your thinking on this at the time?

    b. How easy or difficult would it be to express your thinking about it now?

2. Any assessment results relating to videoed pupil group?

3. Any feedback from Ps re any aspect of the videoed lesson sequence?

Specific questions arising from our analyses of meeting notes were also posed to each teacher filmed. For example:

1. You thought that our coding framework would provide a great framework for observing other Ts. Has this been used / developed? If so, how?

2. Can you comment on your experience of reverting to teaching without the IWB in your new school?

3. Did you show / discuss lesson videos with the class as you intended? What was their reaction?

APPENDIX 5. T-MEDIA Pupil Interview Prompts

1. **Your thoughts on what was good about the lesson**

   The main things that were good
   What made them good

2. **Your thoughts on what you learned about the topic**

   The main things that you learned
   What helped you to learn them

2b. **What your teacher did to help you learn**

3. **Your thoughts on what was difficult in the lesson**

   The main things that were difficult
   What made them difficult
   What helped you with them

4. **Your thoughts on using ICT in the lesson**

   The main ways it helped or not
   What it was that made them helpful or not

5. **Your thoughts on what could have been better about the lesson**

   The main things that could have been better
   What difference they would have made
   Any further comments

6a **Using ICT in the other lesson(s) that were videoed**
   The main ways it helped or not
   What it was that made them helpful or not

6b **Using ICT in the lesson(s) that were videoed since the last interview**
   The main ways it helped or not
   What it was that made them helpful or not

APPENDIX 6.   British Educational Research Association Ethical Guidelines

Introduction

The British Educational Research Association adopted the following set of ethical guidelines at its Annual General Meeting on 28 August 1992. These are based on guidelines developed at a BERA seminar in March 1988 (published in Research Intelligence, February 1989) and the proposed ethical standards of the American Educational Research Association as published in Educational Researcher, December 1991. (We are grateful to the AERA Committee on Standards for permission to adapt their guidelines.)

The Guidelines

1. The British Educational Research Association believes that all educational research should be conducted within an ethic of respect for persons, respect for knowledge, respect for democratic values, and respect for the quality of educational research.

Responsibility to the research profession

2. Educational researchers should aim to avoid fabrication, falsification, or misrepresentation of evidence, data, findings, or conclusions.

3. Educational researchers should aim to report their findings to all relevant stakeholders and so refrain from keeping secret or selectively communicating their findings.

4. Educational researchers should aim to report research conceptions, procedures, results, and analyses accurately and in sufficient detail to allow other researchers to understand and interpret them.

5. Educational researchers should aim to decline requests to review the work of others when strong conflicts of interest are involved or when such requests cannot be conscientiously fulfilled on time. Materials sent for review should be read in their entirety and considered carefully, with evaluative comments justified with explicit reasons.

6. Educational researchers should aim to conduct their professional lives in such a way that they do not jeopardize future research, the public standing of the field, or the publication of results.

Responsibility to the participants

7. Participants in a research study have the right to be informed about the aims, purposes and likely publication of findings involved in the research and of potential consequences for participants, and to give their informed consent before participating in research.

8. Care should be taken when interviewing children and students up to school leaving age; permission should be obtained from the school, and if they so suggest, the parents.

9. Honesty and openness should characterize the relationship between researchers, participants and institutional representatives.

10. Participants have the right to withdraw from a study at any time.

11. Researchers have a responsibility to be mindful of cultural, religious, gendered, and other significant differences within the research population in the planning, conducting, and reporting of their research.

Responsibility to the public

12. Educational researchers should communicate their findings and the practical significance of their research in clear, straightforward, and appropriate language to relevant research populations, institutional representatives, and other stakeholders.

13. Informants and participants have a right to remain anonymous. This right should be respected when no clear understanding to the contrary has been reached. Researchers are responsible for taking appropriate precautions to protect the confidentiality of both participants and data. However, participants should also be made aware that in certain situations anonymity cannot be achieved.

Relationship with funding agencies

14. The data and results of a research study belong to the researchers who designed and conducted the study unless alternative contractual arrangements have been made with respect to either the data or the results or both.

15. Educational researchers should remain free to interpret and publish their findings without censorship or approval from individuals or organizations, including sponsors, funding agencies, participants, colleagues, supervisors, or administrators. This understanding should be conveyed to participants as part of the responsibility to secure informed consent. This does not mean however that researchers should not take every care to ensure that agreements on publication are reached.

16. Educational researchers should not agree to conduct research that conflicts with academic freedom, nor should they agree to undue or questionable influence by government or other funding agencies. Examples of such improper influence include endeavours to interfere with the conduct of research, the analysis of findings, or the reporting of interpretations. Researchers should report to BERA attempts by sponsors or funding agencies to use any questionable influence, so that BERA may respond publicly as an association on behalf of its members thereby protecting any individual or contract.

17. The aims and sponsorship of research should be made explicit by the researcher. Sponsors or funders have the right to have disclaimers included in research reports to differentiate their sponsorship from the conclusions of the research.

18. Educational researchers should fulfil their responsibilities to agencies funding research, which are entitled to an account of the use of their funds, and to a report of the procedures, findings, and implications of the funded research.

19 The host institution should appoint staff in the light of its routine practices and according to its normal criteria. The funding agency may have an advisory role in this respect, but should not have control over appointments.

20. Sponsored research projects should have an advisory group consisting of representatives from those groups and agencies which have a legitimate interest in the area of inquiry. This advisory group should facilitate access of the researcher(s) to sources of data, other specialists in the field and the wider educational community.

21. The funding agency should respect the right of the researcher(s) to keep his or her sources of data confidential.

22. In the event of a dispute between the funding agency and researcher(s) over the conduct of the research, or threatened termination of contract, the terms of the dispute and/or grounds for termination should be made explicit by the funding agency or researcher and be open to scrutiny by the advisory group. If either party feels that grounds for termination are unreasonable then there should be recourse to arbitration by a body or individual acceptable to both parties.

Publication

23. Researcher(s) have a duty to report both to the funding agency and to the wider public, including educational practitioners and other interested parties. The right to publish is therefore entailed by this duty to report. Researchers conducting sponsored research should retain the right to publish the findings under their own names. The right to publish is essential to the long-term viability of any research activity, to the credibility of the researcher (and of the funding agency in seeking to use research findings) and in the interests of an open society. The methodological principle of maximising the dissemination of information to all interested parties is an integral part of research strategy aimed at testing on a continuous basis the relevance, accuracy and comprehensiveness of findings as they emerge within the process of inquiry.

24. The conditions under which the right to publish might be legitimately restricted are:

*   general legislation (e.g. in the area of libel or race relations);
*   undertakings given to participants concerning confidentiality and generally not to cause unnecessary harm to those affected by the research findings; and
*   failure to report findings in a manner consistent with the values of inquiry i.e. to report findings honestly, accurately, comprehensively, in context, and without undue sensationalisation.

25. Publications should indicate whether or not they are subject to reporting restrictions.

26. The researcher(s) should have the right, as a last resort and following discussions with the funding agency and advisory group, to publicly dissociate themselves from misleadingly selective accounts of the research.

27. Funding bodies should not be allowed to exercise restrictions on publication by default, e.g. by failing to answer requests for permission to publish, or by undue delay.

28. Resources need to be made available for dissemination and publication and should be built in to funding.

29. In the event of a dispute over publication, the researcher should seek recourse first to the advisory group and secondly to an independent arbitration body or individual.

Intellectual ownership

30. Authorship should be determined on the basis that all those, regardless of status, who have made a substantive and/or creative contribution to the generation of an intellectual product are entitled to be listed as authors of that product. (Examples of creative contributions are: writing first drafts or substantial portions; significant rewriting or substantive editing; contributing generative ideas or basic conceptual schema or analytic categories; collecting data which requires significant interpretation or judgement; and interpreting data.)

31. First authorship and order of authorship should be the consequence of relative leadership and creative contribution.

Relationship with host institution

32. Institutions should both develop their own codes of practice which govern ethical principles and establish appropriate standards of academic freedom, including the freedom to disseminate research findings. While such codes should be observed within all research, including non-contract research, they are particularly important in respect of contract research. Such codes should be honoured by institutions and researchers in the negotiation of contractual arrangements put forward by funding agencies, and in the carrying out of these obligations once they have been agreed.

33. While academic staff should not engage in contract research without agreement by the institution, the latter should not be allowed to compel academic staff to engage in particular contract research.

34. It is assumed that contracts will in all cases be interpreted reasonably and with regard to due process. However, should a legitimate disagreement arise between the funding agency and the researchers engaged on it, then the researchers' institutions should give the researchers full and loyal support in resolving this disagreement.

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APPENDIX 7: DETAILS OF VIDEO REVIEW PROCESS

Phase 1: the commentary grids

    (a) a time-coded descriptive *summary* of the videoed lesson activities and interactions was produced by the university research team and incorporated in a grid for each lesson: one column per team member

    (b) summary plus video used by whole team to familiarise themselves with the lessons, to reflect and to *comment independently* (in writing); providing unedited video footage allowed repeated playback in the viewer's own time, as in Armstrong and Curran (2006)

    (c) preliminary selection of *'critical episodes'* or teacher strategies (see Powell et al., 2003, on 'critical events'): actions, teacher interventions or pupil-initiated interactions that were key in using technology effectively and/or promoting learning of the topic[1]

    (d) *analytic grid commentary* (applied to salient portions of the viewer's choice) described: what key part the technology and the teacher played, the effectiveness of the approach or strategy in terms of pupil response, learning or motivation; the level of pupil participation (cognitive or physical); whether and how peer interactions appeared to be supporting learning; key contributory contextual and other factors that impacted upon successful use of the technology; and how lesson activities or teaching and learning interactions related to prior or subsequent use of technology. (See grid example in Figure 1)

    (e) researchers and the teacher-colleague noted on the grid *questions* for further discussion with the teacher; the brief was to avoid bias or value judgement, aiming to stimulate rather than present insights (Lyle, 2003). Questions sought to clarify the teacher's rationale, the underlying curriculum objectives, views about the unique contribution of the technology, or to elicit further contextual information. For example, one question read: "Why did you give out paper copies of the diary text when it was also displayed on the IWB?"

    (f) a volunteer academic *subject specialist* within the Cambridge Faculty of Education (and one from an external university in History) viewed the videos in each case; there were two in the case of History and Mathematics. The specialists made independent input at this stage on their own grid copies. Some of their comments were fed back to the teachers as questions during review meetings and during the final interview after the analysis was complete, and teacher responses were incorporated in our analyses.

Phase 2: independent review of combined grids

    (a) four individual review grids were combined in a single document for each lesson, then integrated with excerpts from teacher diaries, teacher and pupil interview transcripts

    (b) teacher, colleague and researchers independently reviewed combined grids (drawing too upon the subject specialist's comments), noting instances of general consensus, apparent differences in reviewers' perspectives, points for discussion in subsequent review meetings.

Phase 3: four video review meetings

Focus: perspectives were articulated, justified, compared, renegotiated and integrated to develop a shared view; meetings 1-3 treated individual lessons systematically in turn; the final meeting identified themes prominent across the whole lesson module

Aims: to identify the main strategies and 'critical episodes' and discuss what made them more or less significant (attending to commonalities and differences of choice or view between reviewers),

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[1] Our video review guidelines were deliberately framed to provide sufficient information for reviewers to act upon, but to be open-ended enough to reveal the features of interest to each individual without overly constraining the process. Commentary was applied only to viewer-selected salient portions of video – but coverage proved fairly extensive.

linking views to theory and previous experience. Initial impressions were thereby verified or abandoned.

Procedure: discussions (about 3 hours each on four occasions over 2 months) were audio-recorded and transcribed to document the evolving interpretations. Lesson videos were available throughout for joint viewing on a laptop computer. One subject specialist joined a review meeting (having observed in person one of the lessons discussed). Specialists' written commentary was circulated beforehand.

Theory building

Researchers circulated a brief glossary before the first meeting summarising and contrasting theories of learning, and elaborating some central constructs of socio-cultural theory. These related to teacher mediation and included terms such as **scaffolding, fading, zone of proximal development, funelling, assistive questioning, dialogic interaction, affordances.** Sample definitions of two terms we used with teachers were:

> *Funnelling / authoritative interaction* – interaction (students giving responses or making contributions) but teacher leading students towards target response or particular interpretation / understanding / solution, by controlling decision making (Bauersfeld, 1988) or guiding via question-and-answer (Mortimer and Scott, 2003).

> *Dialogic interaction* – discussion-based discourse in which teacher recognises and clarifies students' existing understandings and builds upon these to formulate joint understanding (Mortimer and Scott, 2003); intentional sharing / exploration of ideas, collaborative meaning making (students contributing ideas, teachers helping take ideas forward); may involve open-ended questioning, talking through answers, reflecting, interpreting, evaluating.

Coding

(a) Researchers encapsulated these theoretical ideas within an extensive set of preliminary codes (generated during analysis of the preceding T-MEDIA case study, and initially derived from our previous analysis of teacher mediation during the TiPS project) (Hennessy et al., 2005).

(b) Codes were illustrated in grid comments with examples of strategies from the teacher's own (first two) lessons. This tentative coding scheme was discussed and revised at the first meeting.

(c) The coding scheme was then used as a foundation for collaborative construction and continual refinement of the analytic framework at each meeting as new, inductive codes were generated and integrated, the meanings of both kinds of codes were negotiated, and their degree of fit with the data assessed through a complex, recursive process of constant comparison (Glaser and Strauss, 1967). The categorisation ultimately described processes of advance planning and classroom interaction that were linked with carefully specified conditions and consequences.

Finally, the team identified overarching themes and potential exemplars for dissemination, making clear the selection criteria and negotiating the content and structure of the final CD-ROM. This process included generating questions for other teachers to consider (concerning ways of making use of the technology more effective) and discussion of applicability to other contexts, topics and student groups.

It is important to note that a very labor-intensive component of **Phases 1-3** was the preparation and timely distribution of materials to all team members, which proved critically important in supporting the process of joint data review. This involved the project secretary and the lead researcher for the particular case study in summarising or transcribing meeting notes, interviews and videos; continual liaison with the teachers to obtain materials such as IWB slides, lesson plans and handouts; formulating, piloting and revising the instruments, observation record proformas, commentary grids, glossary, video review guidelines; collating, checking and integrating the various data sources (e.g. observation notes, video summary and IWB slides / nondigital whiteboard representations were systematically combined for every lesson); and cataloguing and tracking distribution of the materials comprising a multimedia database for each case (an extended version of the 'video portfolios' employed by Maher and Martino, 1996).

Phased distribution of materials and review of data from 1-3 lessons between meetings helped to avoid overwhelming team members unduly with a large volume of data. Timing was also engineered so that interview data, diary excerpts, and specialist comments for a specific lesson were circulated by the lead researcher only after all team members had commented on the grid (so as to maintain rigor and avoid influencing perceptions), but before the relevant review meeting so that there was time for perusal.

Phase 4: within- and across-subject analyses

(a) *Data sources integrated and coded* using agreed global themes using HyperResearch^{TM} 2.6 qualitative analysis software (www.researchware.com) by the university research team.

(b) Further *analytical review* – by researchers in collaboration with teacher, colleague and subject specialist – included a final teacher interview to further clarify issues emerging from the analysis or raised by specialists. This process culminated in development of a simple but comprehensive *narrative account*, contextualised for each of the four subject areas. The narratives describe and share the individual teachers' approaches, evolving through construction of a 'storyline' for each case study that made sense of the data with particular attention to identified codes (Powell et al, 2003). Each narrative was represented by a map with links to selected video sequences illustrating the main themes identified, plus the informative interview, diary and meeting excerpts ('nuggets'), and review grid commentary from all three groups.

(c) An *overarching account* examined similarities and contrasts of pedagogical approaches within and across cases. See Table 1 for summary table of formal theory and resulting "intermediate theory" terms and breakdown of themes by subject case in Table 2.

APPENDIX 8: Learning theories: a summary

Teaching is based on assumptions about how people learn. Many theories exist, but they can be broadly grouped into three strands, as follows.

1. Behaviourist theories

Behaviourist theories major upon learning as a conditioned *response* to external *stimuli* where environment is the determining factor. The focus is thus on changes in observable behaviour. Complex wholes are assembled out of parts and basic skills are introduced before complex skills. Procedures are emphasised and students are typically trained to respond correctly to instructions.

(Theorists include: Watson, Skinner, Pavlov, Thorndike.)

2. Constructivist theories

Constructivist theories focus attention on the models that a learner employs when responding to new information or to new problems. The concern is with how learners *actively construct meaning, build on their existing knowledge structures,* and make sense of the world through organising concepts and principles. These theories underpin many areas of contemporary educational practice. For example, the present science curriculum is based on a sequential process of constructing knowledge and acquiring 'expert' problem-solving skills – through interaction with others and with objects.

(Theorists include: Piaget, Chomsky, Bruner [whose later work also engaged with socio-cultural perspective], Hirst, H. Simon.)

3. Socio-cultural theories

Socio-cultural theories see learning as occurring through interaction between the individual and the environment. Influences upon development include the institutions, *social settings* and *cultural artefacts* (including language) that make up that environment. Learning involves participation in contextualised activity. It is not necessarily the property of an individual but is shared within the social group *(distributed cognition)*. The collective knowledge of the group/organisation is greater than the sum of the knowledge of individuals. *Activity theory* emphasises the importance of participation but also the *mediating* use of tools and resources available in the specific setting. These artefacts may be material, e.g. computers, books, diagrams, Intranet resource bases etc, or conceptual, e.g. key ideas or processes. The *affordances* of the tool used can shape (enhance or constrain) the activity.

(Theorists include: Dewey, Vygotsky, Rogoff, Lave & Wenger, Engström, Wertsch.)

Implications for teaching:

The teacher plays a critical role in creating an environment in which individuals can be stimulated to think and act beyond their current level of competence. Activities are designed within the individual's *zone of proximal development* (ZPD) so that a student can complete them with *assistance (from teacher or more competent peer)*, which is gradually and purposefully withdrawn as the student takes greater responsibility for their own learning. Thus the teacher (as *mediator*) both diagnoses and operates within the ZPD, providing *responsive assistance* to bridge the gap between pupils' existing knowledge and skills and the knowledge and skills to be acquired.

Tasks are *collaborative* between teacher/student/peers; students are involved in the generation of problems and solutions. Individuals can have different levels of participation in

the activity but the aim is for all to move towards *increased participation*. Pedagogy for using new technological tools is shaped by the prior intentions and approaches of teachers.

Mediating strategies: a socio-cultural framework

The socio-cultural perspective offers a particularly useful framework for understanding how teachers mediate students' interactions with technology to support learning. Mediating action can operate in the following four main areas.

1. Structuring activity

This involves both advance planning and lesson organisation. It includes designing tasks to build on established practice and known pupil characteristics, integrate new tools and resources, exploit their affordances, and link with ongoing teaching and learning activities.

Strategies include: building scaffolding into activities

2. Guiding and supporting self-regulated pupil activity

This involves: proactive and responsive teacher mediation; continual assessment of appropriate level of learner participation; gradually withdrawing support as learners become more capable and their participation in activity increases; *balancing* freedom of choice, pupil agency and self-regulated learning with structured activity and teacher support.

Strategies include: modelling; scaffolding; fading; focusing; shifting responsibility toward learner; assisting performance through questioning; responsive assistance

3. Structuring interpersonal classroom interactions

This may involve: incorporating use of technology as an *object of joint reference* within whole-class, teacher/learner or peer discussion; creating and capitalising on opportunities to share mediating agency (eg with learners/technology); building a stronger classroom culture of sharing ideas, reflections, procedures (with peers and whole class).

Strategies include: assisting performance through questioning; responsive assistance; shifting responsibility toward learner; fading; promoting collaboration;

Forms of communication include: dialogic interaction, dialogic synthesis, authoritative interaction or 'funnelling', authoritative exposition.

4. Adapting to constraints and contingencies

This involves responding to organisational, practical and technical constraints.

Strategies include: structuring lessons in anticipation of, or response to, constraints introduced by using ICT.

GLOSSARY OF TERMS

AFFORDANCES
Perceived qualities of systems that can support or hinder interactions (e.g. dynamic visual representation).

ASSISTED LEARNING / ASSISTED PERFORMANCE
The emphasis is on assisting, rather than directing, performance. The task is carefully tailored to the learner's requirements *(cognitive task structuring)* and placed within the learners' ZPD where it can be performed with assistance (from teacher/peer/technology). Assistance can include modelling, feedback, contingency management, instructing, coaching and questioning; it is steadily decreased as responsibility is shifted to the student.

Use of *assistive questioning* encourages the learner to move their thinking forward, for example by supporting them with mental functions that they cannot produce alone. Assistance may also involve encouraging students' *articulation* of their reasoning and problem-solving processes (Bonk & Cunningham, 1998).

AUTHORITATIVE INTERACTION / FUNNELLING – interaction (Ps giving responses or making
contributions) but T leading Ps towards target response or particular interpretation / understanding / solution, by controlling decision-making (Bauersfeld, 1988) or guiding via Q&A (Mortimore & Scott, 2003).

AUTHORITATIVE EXPOSITION
T-led explanation/presentation of one view. (Mortimore & Scott, 2003)

MODELLING
Students are offered opportunities to observe and emulate or re-invent expert strategies in context, with the teacher 'modelling' processes involved, then providing and adjusting assistance (e.g. Brown, Collins & Duguid, 1989) as the learner becomes proficient.

DIALOGIC INTERACTION
Discussion-based discourse in which teacher recognises and clarifies pupils' existing understandings and builds upon these to formulate joint understanding; intentional sharing / exploration of ideas, collaborative meaning making (Ps contributing ideas, Ts helping take ideas forward); may involve open-ended questioning, talking through answers, reflecting, interpreting, evaluating; with or without ICT; contrasts with 'authoritative' discourse (Mortimore & Scott, 2003).

DIALOGIC SYNTHESIS
T exploring / attending to / drawing together / building on / elaborating different views but no P input during synthesis itself (Mortimore & Scott, 2003).

FADING
The gradual abbreviation and ultimate withdrawal of assistance so that learners' participation increases as independent thinking skills are developed (e.g. Newman, Griffin & Cole, 1989).

FOCUSING
Directing attention towards salient concepts or aspects of a task; may involve both pre-structuring activities or responding contingently during lesson, for example by use of

questioning (e.g. Wood, 1994). Ideally support is more responsive to learners than directive (e.g. Anghileri, 2002).

Mediation
How the (mental and physical) activity of students is shaped by the teacher's plans, actions and interpretations of objects and processes (e.g. Tharp and Gallimore, 1988).

Responsive assistance
Responsive assistance is related closely with the other strategies outlined here. It involves helping the learner to extend their knowledge within the ZPD by *adaptively responding to perceived or emerging learning needs* through adjusting support. Learners may initiate interactions, including opportunistic requests for assistance/feedback as teacher circulates (e.g. Rogoff, 1995; Tharp & Gallimore, 1988).

Scaffolding
Providing assistance (in varying forms) that enables learners to engage in activity at the expanding limits of their competence. Scaffolding may involve both preparing/structuring appropriate tasks and materials (e.g. Anghileri, 2002) and interacting with learners responsively during the lesson (e.g. Bliss, Askew & Macrae, 1996).

Shifting responsibility towards learner
Transferring responsibility to the learner, for example by encouraging a shift from teacher direction towards self-regulation (e.g. through fading). The process is facilitated by continual re-evaluation of the learner's capabilities.

Zone of proximal development (ZPD)
'The zone of proximal development is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers' (Vygotsky, 1978, p.86).

Further reading
Hennessy, S., Deaney, R. & Ruthven, K. (2005) Emerging teacher strategies for mediating 'Technology-integrated Instructional Conversations': a socio-cultural perspective, *Curriculum Journal*, 16(3).

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APPENDIX 9:
CODING ADAPTED AS A DRAFT FRAMEWORK FOR LESSON OBSERVATION

Interaction/Communication

Dialogic interaction-teachers and pupils share/explore ideas. Teacher mediates

Dialogic class discussion-pupils respond to/build on each other's ideas. Teacher mediates, prompts if necessary

Dialogic peer discussion-pupils spontaneously respond to/build on each other's ideas. Teacher is a participant

Dialogic synthesis-drawing together/building on/elaborating different views. Can be teacher or pupil. Draws on whole class and/or group discussions and/or individual work

Funnelling (Authoritative interaction)-progressive focusing of pupils' responses/contributions to a particular answer

Authoritative exposition-teacher led explanation/presentation/presentation of one particular view

Responsive Assistance

Probing-eliciting knowledge/clarifying/diagnosing/developing understanding

Prompting-giving a push, eg to make links

Explaining assistance-teacher assists pupil after request for help or misunderstanding

Assistive questioning-teacher led questioning to help pupils develop knowledge/skill

Scaffolding-supporting/pushing pupils to go further than they can go alone

Avoiding alienation

Reshaping thinking-eg by rephrasing/posing alternative perspectives/increasing sophistication of understanding/widening vocabulary

Making suggestions

Increasing pupil participation, interdependence and responsibility

Rapport develops

Teacher enthusiasm towards pupil responses

Teacher gives status to pupil contributions

Encouraging expression of different ideas/views without criticism (making diversity of ideas legitimate)

Vicarious involvement via guesswork

Feedback-especially positive reinforcement

Audible praise for pupil ideas-giving them a wider audience

Pupil enthusiasm

Pupil initiated interaction with teacher

Pupil requesting assistance

Pupils seeking reassurance

Pupils making suggestions

Pupils using technology themselves (eg interactive whiteboard)

Paired/group discussion

Facilitating whole class collaboration/sharing of ideas-for example, collective annotation of information on whiteboard

Teacher as learner/co-construction of knowledge-developing the sense of a shared journey and equal collaboration

APPENDIX 10: CD-ROM DESIGN ISSUES AND DECISIONS

- *Spoken teacher introduction* (with photograph) to their aims and objectives included.

- *Tour of the Disc tutorial* recorded with Camtasia Studio.

- Clip selection reflects the fact that *technology was only a part of the lessons* – some clips show no technology use – and counters the notions that technology is an agent of learning or reduces the teacher's role

- *Mindfulness of technology changing rapidly and of variable provision;* focus is on pedagogy, and latest features of technology / software are highlighted in the Across Subjects resource.

- Format is fully *interactive* using menus and hyperlinks; video can be paused, replayed, etc.; no automatic linking/video playing. *Non-linear* structure exploits possibilities of multimedia (analogous with website), as *flexible* as possible with different *strands* to follow – *mapped* out on Disc Overview.

- *Structure resource thematically AND chronologically by lesson.* Latter strategy is helpful to see unit as whole and (teacher) progression through unit and to see links emerging with previous and future work but also helpful to illustrate many different examples of one theme.

- Some hyperlinking on *key terms to highlight glossary definitions* and bold tags on rest, but codes illustrated in context; themes contain list of (and hyperlinks to) clip examples under each term.

- *Layout:* still images / slides can be accessed via clickable links under the video window.

- Ensure *size of font and buttons* is large enough – many resources have font too small.

- *Ideally allow users to annotate video, mark time-coded segments* for subsequent discussion with colleagues (cf. Pea et al 2004); not technically feasible. Text template offered with questions and space for responses.

- *Should sequence of clips represent all six lessons?* Not necessarily but maintain continuity in other ways, e.g. using narrative links in clip introductions.

- *Resources bank includes lesson plans and materials* that could be downloaded/adapted for use with / without IWB; resources organised lesson by lesson and easily navigable. Pupil work included, separately labelled.

- *Menu option for resources* so they can be accessed quickly. Associated resources and activities accessible from area adjacent to video.

- Whole *sequence of slides* included – not just those featured on selected clips.

- Balance between clear, informal *language* and patronising language; allow access at different levels.

- Multipage sections to be *navigated via forward and back buttons or vertical scrolling?* Latter slower but allows viewing of overlap. Decision to have usually no more than one window length of scrolling.

- *Site map* used to orient learners to organisation of content, but *menu* linking to all main areas is permanently accessible on left, for navigation.

APPENDIX 11: TECHNICAL DESIGN ISSUES

In representing complementary interpretations of a single video record using hyper-media, several technical issues needed to be addressed. The main issues we considered included simultaneous use and proximity of multiple representations, cognitive load, and degree of user control over navigation, contextual factors that may limit generalisability (National Research Council, 2001), and the merits of the 'guided noticing' paradigm developed by Pea et al. (2004) for expressing multiple perspectives on significant interactions. The more technical related theory is summarised below for interested readers (some of the resulting decisions made were listed in Appendix 10). Note that most effects are minimal in controlled studies and in all cases having users enough time and motivation to explore a resource may compensate for design deficiencies, thus *user strategies are much more critical than design principles* (Zahn et al., 2004).

Design principles from the literature on multimedia and hypertext design

- *Cognitive theory of multimedia learning* (Mayer, 2001) indicates that enriching visual or auditory text with pictures/animation improves performance (because learners actively make connections) but other findings (Opfermann et al., 2005) contradict this, possibly because learners could skip representations or retrieve them after reading text.

- Similarly, effectiveness of *multiple representations* (MRs) depends on purpose (Ainsworth, 1999), and theoretically: (a) constraining interpretation – it may be difficult to translate between MRs so automatic translation or sequential presentation is needed; (b) complementary roles, e.g. different or partially different information discourages translation; (c) comprehensibility – to benefit from multiple representations in constructing deeper understanding of complex idea, learners must understand relations between them.

- *Cognitive load theory* (Sweller 1999) suggests integrating or minimising the number of simultaneous representations to avoid *redundancy* and *split attention* effects; avoid narration with an identical text; avoid extraneous stories, background music/sounds, detailed textual descriptions as these are distracting and disruptive (Clark and Mayer, 2003).

- *Contiguity principle* suggests corresponding text and graphics need to be temporally and spatially proximal, e.g. via overlaying or pop-up boxes or integrating textual explanations into graphic elements (Clark and Mayer, 2003).

- *Degree of user control,* e.g. over pace and sequence, selection of content and depth of information actively sought out, choice of representational format. Clark and Mayer (2003) and others propose that learners with low prior knowledge or poor metacognitive skills benefit from greater structure, less control (except over pacing), as they are unable to establish information needs in advance. Opfermann (2005) found higher control meant less efficiency (slower learning), regardless of prior knowledge. However learners are more motivated with higher control, especially later in learning when material is more complex (as in our CDs). *Site map*s are rarely used for navigation (Clark and Mayer 03).

- Other work (Zahn et al, 2004) confirms that prior knowledge and representational format have minimal/no influence and *user strategies in actively managing complex information structures* (see Bannert 2002 on managing cognitive load) *are much more critical than design principles*. Without any instruction, most users watched video first then reviewed it with linked information. Schwann et al (2005) found focused repeaters were more successful than surfers.

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