From design to narrative: the development of inquiry-based learning models

Conference Item

From design to narrative: the development of inquiry-based learning models

Gráinne Conole,[1] Eileen Scanlon,[1] Cindy Kerawalla,[1] Paul Mullholland,[1] Stamatina Anastopulou[2] and Canan Blake[1]
[1]The Open University, [2]University of Nottingham

Abstract

The University of Nottingham and the Open University are partners in a ca. £1.2m project to help school students learn the skills of modern science. The three-year project, Personal Inquiry (PI)[1] (funded by the UK ESRC and EPSRC research councils), is developing a new approach of 'scripted inquiry learning', where children investigate a science topic with classmates by carrying out explorations between their classroom, homes and discovery centres, guided by a personal computer. This paper describes our progress to date on the development of four models for inquiry-based learning, as part of the PI project. These are being used as the basis for the development of educational scenarios and associated scripts to explore the use of mobile technologies in supporting an inquiry-based approach to teaching Scientific thinking across formal and informal learning.

Introduction

The PI project is adopting a scripted inquiry learning approach to support children to understand themselves and their world. Specially constructed scripts will act like dynamic lesson plans and will guide the children through their process of investigation across formal (in the classroom) and informal (outside of school, in discovery centres or in the home) learning settings. This work, in part builds on the work done by Dillenbourg and others on the development of scripts for computer-supported collaborative learning (Dillenbourg and Jerman, 2007, Dillenbourg and Tchounikine, 2007, Dillenbourg et al. 2004, Dillenbourg, 2004). The aim is for children to explore the use of a range of technologies in coming to understand themselves and their world through a new approach of scripted inquiry learning. The scripts are designed to support the children in developing an inquiry-based approach, including support for formulating questions and hypotheses, gathering and evaluating evidence, conducting investigations, representing and analysing data and discussing findings with other students, their teachers and their family.

The project sees pedagogy and technology as intimately interlinked. We have adopted an iterative, participatory approach to the design, development and evaluation of the scripts. We are holding focus groups, design workshops, and discussions of the prototypes with teachers and learners, as well as with key educational experts, software designers, curriculum developers, curators of informal learning and discovery centres. The key questions driving the design and evaluation are:

1. How can scripted inquiry learning support effective learning across transitions between formal and informal settings?
2. How do school students and their teachers adopt the technologies as tools for learning?
3. How does the experience of scripted inquiry learning assist and change learning activities?
4. How do scripted inquiry learning activities develop children's learning skills?

The focus is based around topic themes of relevance to the secondary-level UK National Curriculum (Myself, My Environment, My Community) that engage young learners in investigating their world. The aim is to develop inquiry learning scripts which encourage thinking and debate about issues that affect students' everyday lives, such as fitness, diet and waste. The initial phase of work has focussed on preparation for the first set of pilot studies in February 2008. For these, each site (University of Nottingham and the Open University) is working closely with local partners. The main aim of these is to test out our

---

[1] This project is part of ESRC's Teaching and Learning Research Programme (see www.TLRP.org)

procedures and technologies before the main trials scheduled for June. The OU is working with a Milton Keynes school, and for the February trials is focusing on the development of educational scenarios using an inquiry-learning approach to the investigation of urban heat islands, as part of the Geography GCSE curriculum. The University of Nottingham is also working with a local school and is focusing on inquiry learning in Biology, through exploration of factors, which effect changes in heart rate. Both the OU Nottingham are also working with a number of local educational, leisure and cultural centres. This will enable us to explore the use of scripts in both formal classroom environments and more informal settings.

Using the concepts of design and narrative in the development of inquiry models

The main focus of this paper is the work we are doing, as part of the PI project, to explore mechanisms for developing inquiry-based learning models, which can be used as a basis for the development of the educational scenarios. As discussed earlier, a central tenet of the project is the co-development of innovative approaches to both pedagogy and technology. In order to achieve this we are bringing together a number of different theoretical perspectives from the literature.

The first theoretical perspective comes from the large body of knowledge on inquiry-based learning; from empirical studies on the best approaches to facilitating inquiry-based learning through to more conceptual and theoretical work on the nature of inquiry. We have undertaken a detailed review of the literature on inquiry learning (Scanlon et al., 2007). We began by reviewing the background to the development of ideas about inquiry learning, and some definitions arising from different perspectives on the topic. We then reviewed work on science-based inquiry learning; contrasting this with work in other subject areas. We explored the variety of ways in which technology has been deployed to support inquiry learning experiences. We identified a number of challenges to the development of effective inquiry learning. Finally, the last section of the review described a number of existing inquiry learning scenarios. From this review we have been able to develop a clearer understanding of the nature of inquiry learning, its key characteristics and have identified examples of inquiry-based learning models which have been developed and used successfully. We used this literature review as the basis for developing four inquiry-based learning models which are described in this paper. The models will form the basis of the educational scenarios and associated scripts that we will be developing and testing in the PI project.

The second theoretical perspective comes from the body of work on designing educational scenarios or the designing for learning literature (see for example Beetham and Sharpe, 2007; Lockyer et al., 2008). Design refers to the process and artefacts associated with the planning and creation of educational scenarios. It includes the decision making involved in the planning of an educational scenario. The third theoretical perspective is work on narratives – the different ways in which educational scenarios can be presented to learners. A distinction is often made between story and narrative. A story is a collection of facts (events, actions, locations, people, etc.). Narrative relates to the particular way in which the facts are arranged and conveyed to a reader (Genette and Lewin, 1983; Brooks, 1996; Chatman, 1978; Szilas, 1999). Narratives provide coherence by arranging story facts in certain expected patterns. Plot structures are examples of these patterns. Narratives often recount a series of events, however, the chronological order in which story events occur and the order in which they are narrated need not be the same (Genette and Lewin, 1983).

Table 1 Benefits of design and narrative

Design
It can act as a means of eliciting designs from designers/teachers in a format that can be tested and reviewed with developers, i.e. a common vocabulary and understanding of learning activities.
It provides a means by which designs can be reused, as opposed to just sharing content.
It can guide designers/teachers through the process of creating new learning activities.
It creates an audit trail of the design decision-making process.
It can highlight policy implications (staff development, resource allocation, & quality).
Narrative
It provides a means of illustrating to the designer/teacher how the educational scenario will look on implementation
It can provide a means of scaffolding or guiding students through the activity sequence
It can provide a way in which inquiry learning can be expressed and how different routes through/instantiations of

inquiry learning scripts can be understood
It can provide ways in which learners can express their understanding, construct an argument
It can provide ways in which the students work can be organised and reviewed on an individual, group or class level, highlighting different themes

Although 'design' and 'narrative' are distinct literatures in their own right, for the purpose of our work we see them as interlinked. We believe that concepts of 'design' and 'narrative' are powerful ideas, which have been used extensively across the discipline domains that feed into technology-enhanced learning. We argue that the concepts of design and narrative are central to the development and implementation of the educational scenarios that are core to the PI project. Articulation of the role of design and narrative is valuable in a number of respects, as they: provide clarity about the different ways in which educational scenarios can be formally represented and provide guidance on ways in which we can provide 'scaffolds' to support designers/teachers in the creation of educational scenarios, as well as 'scaffolds' to support teachers/students in the orchestrating and running of educational scenarios. We have produced a positional paper which reviews the literatures around design and narrative and their associated benefits; Table 1 provides a summary (Conole and Mulholland, 2007).

A central concept used in the PI project is the notion of 'educational scenarios'. The term educational scenario is used loosely in the literature but seems to be predominately concerned with the description of a sequence of educational activities undertaken according to a particular pedagogical approach. Educational scenarios can be 'codified' into a number of different forms of representation, which each foreground different aspects of the educational scenario and which provide a means of illustrating the inherent design (Conole, 2008a). These can either be used for creation of educational scenarios (i.e. design) or as a means of representing the delivery of an educational scenario (i.e. narrative). These forms of representation range from rich contextually located examples of good practice (case studies, guidelines, etc.) to more abstract forms of representation that distil out the 'essences' of good practice (models or patterns). Figure 1 provides an illustration showing an educational scenario at the centre, with examples of a number of different ways in which this educational scenario can be described – i.e. forms of representation. These 'abstractions' (or forms of representation) of the educational scenario can then be used as the basis for supporting the design process of creating a new educational scenario or as a means of constructing a narrative that guides users through the process of using the educational scenario.

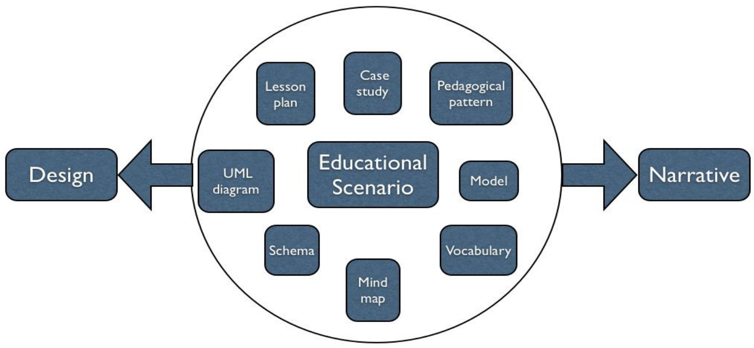

Figure 1: Representations of educational scenarios

An educational scenario can be viewed as a particular instantiation of a learning model for a given subject and within a particular context. Different forms of representation of the educational scenario provide different levels of detail and focus (educational, process/operational or technical). In this paper we combine this background work on design and narrative with our review of inquiry-based learning to develop four generic inquiry learning models.

The nature of inquiry learning

From our review of the literature it is evident that there are four main purposes of inquiry learning:
1. To find the answer to a particular question of a scientific nature
2. To learn something about underlying scientific concepts
3. To find out how to go about answering scientific questions
4. To develop skills and competencies in using scientific tools and techniques

Articulation of these purposes is important because it helps to clarify the focus of inquiry learning and helps to differentiate it from other pedagogical approaches. It also suggests that an inquiry-based approach aligns well with particular disciplines – namely those that involve an element of scientific thinking. Outlining the purpose of inquiry is also important in that it provides a useful checklist against which any developed models can be validated.

To develop a more detailed understanding of the nature of inquiry learning, we used the literature review as a basis for distilling out the key characteristics or significant features of inquiry learning. Four main characteristics emerged and are listed here:

1. **Questioning and hypothesis**: Learners are engaged by scientifically oriented questions (Grandy and Duschl, 2007). Learners asking questions about the natural or material world, collecting data to answer those questions, making discoveries and testing those discoveries rigorously (de Jong, 2006) or making hypothesis and predictions about natural phenomena. (Osborne et al., 2005)
2. **Adopting an evidence-based approach:** Learners give priority to evidence that allows them to develop and evaluate explanations that address scientifically oriented questions (Grandy and Duschl, 2007). Learners foreground the adoption of an evidence-based approach to tackling an issue.
3. **Synthesis and metacognition:** Learners need good meta-cognitive skills to make sense of their actions and observations and to be able to link these to the underlying theoretical concepts. Learners formulate explanations from evidence to address scientifically oriented questions (Grandy and Duschl, 2007). The development of an 'integrated' scientific understanding i.e. the combination of knowledge of scientific concepts, understanding of scientific tools and inquiry skills (Edelson et al., 1999).
4. **The nature of Science:** Learners evaluate their explanations in light of alternative explanations particularly those reflecting scientific understanding (Grandy and Duschl, 2007) and the claims of others. Learners need to develop critical skills to evaluate the epistemological basis on which Scientific claims are made. There is a diversity of scientific thinking; students need to understand that there are a range of methods and approaches and that there is no one scientific method or approach. (Osborne et al., 2005). Creativity - students should appreciate that science is an activity that involves creativity and imagination (Osborne et al., 2005) Science and questioning - students should be taught that an important aspect of the work of a scientist is the continual and cyclical process of asking questions and seeking answers, which then lead to new questions (Osborne et al., 2005). Learners are encultured into the thinking and practices of Scientific disciplines. Science learning should be authentic to science practice (Dewey, 1938; Abd-el-Khalik and Lederman, 2000).

Edelson et al. (1999) lists a range of inquiry-learning approaches: discovery, controlled experimentation, modelling, synthesis of primary sources and exploration of quantitative data, and argues that each requires the development of a particular set of skills. It is evident from the literature, for example that learners need to develop a particular set of communicative skills. They need to be able to communicate their findings and justify their proposed explanations (Grandy and Duschl, 2007). This communicative process spans the inquiry process – beginning with questioning (and sometimes hypothesis) through to explaining and arguing based on findings and an interpretation of those findings. Being able to handle and manipulate data is key, as are skills in analysing and modelling and persuading the scientific community that the specific methods, evidence or outcomes are significant. Learners adopting an inquiry approach also need to be able to visualise data in a variety of different formats (as tables, as graphs, as equations, as diagrams, as 3D-models) and understanding what these different representations offer. Benefits from adopting an inquiry approach relate to a greater understanding of science and an understanding of how people reason compared to how scientists reason.

Examples of inquiry learning models

Our review of the literature included a description of a range of inquiry learning models that have been developed and tested; these have informed the development of the models we describe in this paper. To give a flavour of this work three brief examples are provided here. We used these as the basis for identifying four distinct types of inquiry learning models which are outlined in the next section.

Wells (2001) has developed and tested a framework for dialogic inquiry (Figure 2) and divides the process of inquiry into three stages ('research', 'interpret' and 'present'). Each stage has stated aims and activities, along with the types of dialogue that could be used to achieve these. The model therefore uses collaboration as an important driver for supporting the inquiry learning process.

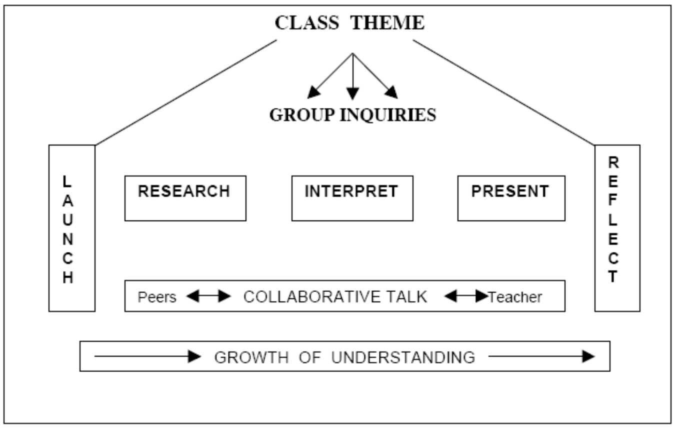

Figure 2: Well's model of dialogic inquiry

A model, which includes hypothesis as a key component, has been developed by Weinberger, Stegmann, Fischer and Mandl (2007), who adopted a Learning By Design (LBD) approach to science learning. They discuss two interlinked iterative cycles of scripted activity in which scientific questions are answered through students building models and testing them out: iterative design/redesign (cycle 1): understand challenge, plan design, present and share posters, construct and test, analyse and explain, present and share gallery walk and iterative investigate and explore (cycle 2): clarify question, make hypothesis, design investigation, conduct investigation, analyse results, present and share poster session. This iterative approach therefore helps to reinforce the essence of hypothesis and investigation in inquiry learning.

An alternative integrative example which explicitly includes modelling is SCI-WISE (Social and Cognitive Improvement Within an Inquiry Support Environment), which consists of knowledge-based software agents/advisors (inventor, analyzer, collaborator) that provide contextual advice and other information. The advisors can also prompt students to do activities such as reflect on or assess their work. The students can also modify the advisors so they can meet personal knowledge building goals or learning styles. It engages students in a six-step inquiry cycle (hypothesize, investigate, analyze, model, evaluate, and question). By giving general advice (rather than step-by step procedures), the system is intended to help students conduct experiments that are more epistemologically authentic.

Different types of inquiry learning models

We wanted to see if we could develop some inquiry models which foregrounded these different aspects of the inquiry process. We have articulated four distinct models from this literature which seem to us to encapsulate particular aspects of inquiry learning:

- **Peer, collaborative inquiry learning –** where the emphasis of the model is to facilitate and scaffold learners in dialogue and discussion around the inquiry process. We see this as a mechanism in particular for supporting the learner in becoming enculturated into a Scientific way of thinking and therefore it supports the 'nature of science' characteristic outlined above.

- **Hypothesis-driven inquiry learning** – where the emphasis is on the inquiry process beginning with a hypothesis and designing the methods to prove it right or wrong. This fits with the 'questioning and hypothesis' characteristic.
- **Multiple forms of representation** – where the model helps guide the learner in seeing data in different formats, extracting information from different formats, understanding the relations between changes in representations and changes in actions or observations and helping them to understand the value of these different forms of representation. The model also helps the learner in dealing with noise in data and with erroneous data collection processes, while reflecting on the process and synthesising the scientific outcomes of each representation. This fits with the 'synthesis and metacognition' characteristic.
- **Modelling** – where the model enables the learner to use modelling as part of the process of investigation. This fits with the 'adopting an evidence-based approach' characteristic.

Table 2 maps the pedagogical approaches that are needed in each of these four models. Of course these models represent extremes and the pedagogical approaches listed are seen as the minimal requirements in each case. But by separating out these different specific aspects of inquiry learning – collaboration, hypothesis, multiple representation and modelling, we will be in a better position to identify what constitutes an appropriate, technology-enhanced environment to support the inquiry process. And indeed in reality this does not preclude combinations of approaches or models from occurring – for example a peer collaborative approach to modelling or combining a hypothesis model with one demonstrating different forms of representation. The next section will describe each of these models and will discuss how we plan to use these as the basis for the development of our educational scenarios in the PI project.

Table 2: Four aspects of inquiry learning

Pedagogical features	**Orientate**	**Hypothesise**	**Design**	**Discuss**	**Interpret**	**Analyse**	**Model**	**Investigate**	**Represent**	**Reflect**
Peer collaboration	√			√	√					√
Hypothesis driven	√	√	√		√	√		√		
Multiple representations	√				√			√	√	√
Modelling		√				√	√	√		

The following models take different combinations of the above and represent different flavours of inquiry learning. Each model consists of three main parts: articulation of the pedagogical approaches instantiated in the model, description of the types of tools which are needed to guide the learner through this process of inquiry – these are taken from the identified pedagogical approaches and a central schema, detailing one instantiation of the model, which can then be used as the basis for the script development. Table 3 provides a summary of the key characteristics of these four models in terms of their 'design' and 'narrative'.

Table 3 Design and narrative characteristics

Model	**Design**	**Narrative**
Peer collaboration	Design focus is how to define/orchestrate collaboration/debate, when and how it should occur, how to summarise discussion outcomes and findings.	Narrative focus is how to represent dialogue in ways useful to the learner/teacher – i.e. different debates, themes and issues over time.
Hypothesis driven	Design focus is how to create an environment that guides the learner from hypothesis formulation to inquiry, ensuring appropriate decisions are made according to the nature of the question.	Narrative focus is to show the learner how their inquiry activity was a progression from their initial hypothesis formulation.
Multiple representations	Design focus is how to guide the learner though the selection and use of different	Narrative focus is helping the learner to understand how the different representations they have used

	representations and reasoning from these representations.	relate to each other, and how conceptualisation evolves through their use.
Modelling	Design focus is specifying the modelling task, how modelling should be carried out and the constructs out of which the model should be built.	Narrative focus is helping the learner to understand how they developed and refined their model during the task and the theoretical implications and rationale underlying it.

Peer collaborative inquiry learning
The focus of the first model is to emphasise the dialogic aspects of inquiry learning. This is important as part of learners coming to understand the nature of science and its associated discourses and practice. Therefore the model begins with a question or problem being set. The students then work individually and collaboratively to tackle the question, coming together to synthesise their findings and finally they collectively reflect on the process. The key pedagogies in this model are: orientate, discuss, interpret and reflect. Hence the associated tools developed to guide learners, i.e. the script need to reflect these. Orientation tools might take the form of a question and answer space for students to clarify understanding. Discussion and collaboration tools could take a range of formats – both synchronous and asynchronous but might include scaffolding and guidance to help the students develop their arguments and understanding. Interpretative tools would guide the learners in making sense of their findings and relating these back to underlying Scientific concepts. Similarly the emphasis on the reflective tools would be to help the student take a critical stance to their findings and to enable them to develop their metacognitive skills in terms of framing this particular aspect of work in the wider context of scientific understanding.

Hypothesis driven inquiry learning
The hypothesis model foregrounds the questioning and hypothesis characteristic of inquiry learning. The tools of importance in this model are concerned with supporting the learner in the development of their hypothesis, designing and conducting the investigation, and analysing the results. The hypothesis model emphasises six main pedagogical approaches: orientate, hypothesise, design, investigate, interpret and analyse. In addition to the orientation tools described above, this model would need to included tools which specifically help the students with the development of their hypothesis, how they go about designing and investigating the problem and then support for interpretation and analysis.

Multiple forms of representation
A fundamental aspect of Scientific thinking is for students to be able to 'see', 'interpret' and 'manipulate' data and concepts in a variety of different formats and to develop an understanding of the purposes of each of these different forms of representation. The third model focuses on this, and hence the tools are those which enable learners to explore different forms of representation of data and concepts. Edelson et al., (1999) propose a technology to support inquiry learning that focuses on visualisation of quantitative geographical data for learners. The pedagogical emphasis here is very much on representation and interpretation. There are numerous tools which could be included in this model to aid different types of representations – graphical software, mindmaping, 3-D visualisation tools etc. What's more important than the tools is the ways in which they are used within the model, so the associated scaffolding in terms of guiding the students on how to use these tools and why they are using them is key. An understanding of why each tool is used relates to reflective practices that engage learners in informed scientific choices.

Modelling
The final model focuses on a specialised aspect of inquiry learning, namely the role of modelling. An interesting example of modelling software that has been used extensively to support the development of Scientific thinking is STELLA (see Doerr, 1996 for a review). It provides a multi-layer environment for modelling, which enables the learner to switch between more descriptive representations of a process to the underlying mathematical constructs.

The models in practice

The previous section has outlined the four models and their associated pedagogical approaches and tools. This section provides a concrete example of an educational scenario which could be derived from one of the four models, namely the peer collaborative inquiry model. The scenario consists of seven main stages:

1. The teacher poses an open question, of interest to students, to prompt debate.
2. Students use their handheld devices linked to a classroom data projector to generate initial responses, which are automatically clustered and displayed along different dimensions.
3. The software selects teams of students whose answers differ along the dimensions and sets them the challenge to move closer in agreement through inquiry and debate.
4. Each team chooses one or more methods of inquiry, such as 'debate with expert' or 'run experiments outdoors'.
5. Software running on their mobile devices provides tools and curriculum materials to structure their investigations as they move between locations, and to transmit the results to a team website;
6. The script-based system guides the students at home and in school to share data, analyse the evidence, and try to reach consensus;
7. Their results, and changes in response to the initial question, are presented and compared in the classroom through a discussion mediated by the teacher.

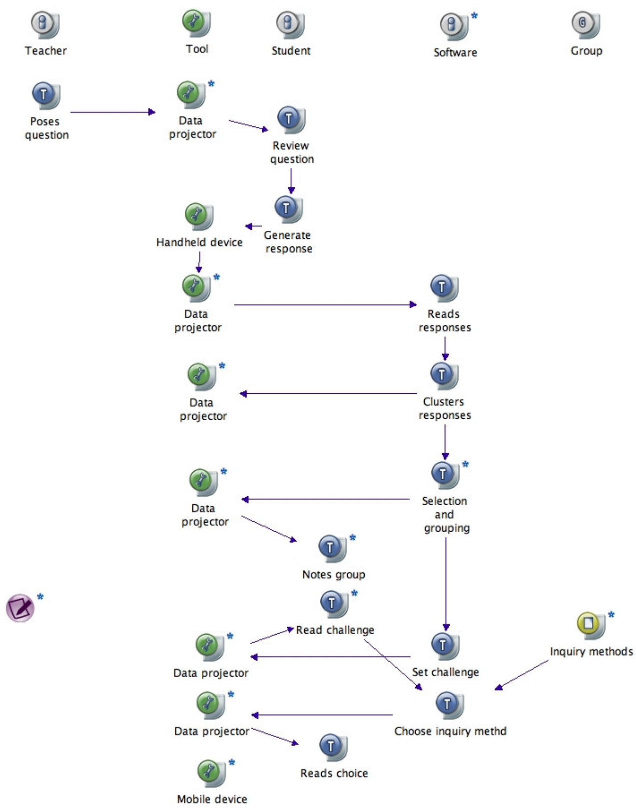

Figure 3: A schema of the example educational scenario

A partial representation of a schema for this educational scenario is illustrated in Figure 3. This schema representation shows the relationships between the different components involved in the scenario (roles, tools, tasks, etc) and some indication of the temporal sequence involved This has been mapped using a Learning Design adapted version of Compendium (Conole, 2008b). From this mapping of the sequence of activities and the relationships between the different components involved, the next stage is to consider what tools might be appropriate to support the process, and in particular the four main pedagogical aspects of 'orientate', 'discuss', 'interpret' and 'reflect' listed early as important elements of peer collaboration. These might take the form of adapted generic tools (for example scaffolded use of a blog or an e-portfolio as a reflective research journal, structured use of a discussion forum as a space for peer discussion about the activity or orientation via a set of web pages which provide initial guidance about the task). Alternatively the tools might be specifically designed to promote inquiry learning. One example of a specialised tool, which we have developed to promote dialogic and argumentation skills, is the Interloc tool (McAlister et al. 2004, Ravenscroft and McAlister, 2006). By characterising the pedagogical aspects of inquiry learning and making explicit the associated pedagogical approaches involved in each, in our view it is possible to make a more considered judgement about what tools and environment will be most appropriate.

Conclusion

This paper has described how four pedagogically driven models for inquiry-based learning have been developed. We argue that these can be used as the basis for developing inquiry-based learning scripts to promote scientific thinking and we will be exploring their use as a potential basis for our inquiry learning scripts within the PI project. The models ensure that the scripts developed instantiate the best in current thinking on what constitutes good pedagogy in inquiry learning. The models have been derived through an extensive review of the literature and are adaptations of existing tried and tested models.

Acknowledgements

We are grateful to the EPSRC/ESRC research councils for providing us with the grant to undertake this work. This paper is part of a large, interdisciplinary project, the principal investigators are Mike Sharples and Eileen Scanlon. further details about the PI project can be found on the project website http://www.pi-project.ac.uk/. Shaaron Ainsworth, Charles Crook, Mark Gaved, Ann Jones, Mike Sharples and Michael White provided valuable feedback on two PI working papers from which this paper is developed; other key members of the research team who have contributed to this work are Steve Benford, Trevor Collins, Chris Greenhalgh, Karen Littleton, Claire O'Malley, Hazel Martin, and Alison Twiner.

References

Abd-El-Khalik F and Lederman N (2000), improving science teachers' conceptions of nature of science: a critical review of the literature. International Journal of Science Education, 22, 7, 665-701

Beetham, H. and Sharpe, R. (2007), Rethinking pedagogy for a digital age - designing and delivering e-Learning, Routledge:London.

Brooks, K. M., (1996), Do story agents use rocking chairs? The theory and implementation of one model for computational narrative. Fourth ACM international conference on Multimedia, Boston, USA, ACM Press, pp. 317-328.

Chatman, S., (1978), Story and Discourse: Narrative Structure in Fiction and Film. Cornell University Press, London.

Conole, G. (2008a), Capturing practice: the role of mediating artefacts in learning design, in Handbook of Research on Learning Design and Learning Objects: Issues, Applications and Technologies, L. Lockyer, S. Bennett, S. Agostinho, and B Harper (Eds), Information Science Reference

Conole, G. (2008b), Using Compendium as a tool to support the design of learning activities, in A. Okada, S. Buckingham Shum and T. Sherborne (Eds) Knowledge cartography – software tools and mapping techniques, http://kmi.open.ac.uk/projects/kc-book/.

Conole, G. and Mulholland, P. (2007), Using the concepts of design and narrative, PI working paper No. 2, Milton Keynes: The Open University.

de Jong, T. (2006). Computer simulations - Technological advances in inquiry learning. Science, 312(5773), 532-533.

Dewey, J. (1938). Logic: The theory of inquiry: Holt, Rinehart and Winston

Dillenbourg P (2004).Framework for integrated learning. Kaleidoscope JEIRP MOSIL Deliverable 23.5.1 – 31.12.2004

Dillenbourg P, Jermann, P., Weinberger, A., Stegman, K., Fischer, F. (2004).A framework for integrated learning scripts. Kaleidoscope JEIRP MOSIL Deliverable 23.4.1 – 31.12.2004

Dillenbourg P., Tchounikine P. (2007) Flexibility in macro-scripts for computer-supported collaborative learning. Journal of Computer Assisted Learning 23(1) 1-13

Dillenbourg, P. and Jermann, P. (2007), Designing integrative scripts. In F.Fischer, I. Kollar, H. Mandl and J.M.Haake (eds) Scripting computer-supported collaborative learning, NY: Springer.

Dillenbourg, P. Jermann, A. Weinberger, K. Stegman, F. Fischer and the members of the MOSIL Jeirp (2004), A framework for integrated learning scripts, Kaleidoscope – JEIRP MOSIL -Deliverable 23.4.1 – 31.12.2004. Accessed Nov 2007 from http://craftwww.epfl.ch/mosil/deliverables/D23-4-1.AVEC.pdf

Doerr, H. (1996), Stella ten years later – a review of the literature, International Journal of Computers for Mathematics Learning, Vol. 1, No. 2, 201-224.

Edelson, D., Gordin, D., & Pea, R. (1999). Addressing the challenge of inquiry-based learning through technology and curriculum design. Journal of the Learning Sciences, 8(3/4), 391-450.

Genette, G., Lewin, J. E., 1983. Narrative discourse: An essay in method. Cornell University Press, Ithaca, NY.

Grandy, and Duschl, R. (2007) Reconsidering the Character and Role of Inquiry in School Science: Analysis of a Conference, Science & Education, Volume 16, Number 2 p. 141–166

Lockyer, L., Bennett, S., Agostinho, S and Harper, B. (2008), Handbook of Research on Learning Design and Learning Objects: Issues, Applications and Technologies, Information Science Reference

McAlister, S., Ravenscroft, S. and Scanlon, E. (2004), Combining interaction and context design to support collaborative argumentation using a tool for synchronous CMC, Journal of Computer Assisted Learning 20 (3), 194–204.

Osborne (2003). Towards Evidence-based Practice in Science Education 3: Teaching Pupils 'Ideas-about-science'. Teaching and Learning Research Briefing, No. 3, June 2003. London: Teaching and Learning Research Programme

Osborne, J., Simon, S.A. & Monk, M. (2005) Enhancing the Quality of Argument in Science Lessons. Final report to ESRC (R000237915).

Ravenscroft, A. & McAlister, S. (2006). Designing interaction as a dialogue game: Linking social and conceptual dimensions of the learning process, Chapter 4 in Juwah, C. (Ed.), Interactions in Online Education: implications for theory and practice. Routledge, 73-90.

Scanlon. E., Kerawalla, C., Anastopoulou, S. and Blake, C. (2007), Inquiry-based learning literature review, PI working paper No. 2, Milton Keynes: The Open Univeristy.

Shimoda, T.A., White, B.Y. Frederiksen J.R. (2002). Student goal orientation in learning inquiry skills with modifiable software advisors. Science Education, 86 (2), pp. 244 – 263.

Szlias, N., 1999. Interactive drama on computer: beyond linear narrative. In Proceedings AAAI Fall Symposium on Narrative Intelligence, North Falmouth MA, AAAI Press, pp. 150-156.

Weinberger, A., Stegmann, K., Fischer, F. & Mandl, H. (2007). Scripting argumentative knowledge construction in computer-supported learning environments. In F. Fischer, H. Mandl, J. Haake, & I. Kollar (Hrsg.), Scripting computer-supported communication of knowledge - cognitive, computational and educational perspectives (S. 191-211). New York: Springer.

Wells, G. (2001)Action, Talk and Text: Learning and Teaching Through Inquiry, Teachers College Press. [there is an article online, based on Chapters 1 and 10 of this book. Accessed online Nov 2007 http://people.ucsc.edu/~gwells/Files/Papers_Folder/ATT.theory.pdf]