Conference Plenary

HOW CAN INTERACTIVE MULTIMEDIA ENHANCE LEARNING?

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Abstract

This presentation will describe work carried out within the MENO (Multimedia, Education and Narrative Organisation) project, which has investigated the role that narrative plays in a non-narrative medium. Our findings show that the commercially-produced multimedia CDs which are predominant in the school curriculum, lack the kind of task structure and interface dynamic that enable pupils to retain control of their own narrative. The presentation will describe the design features that 'afford' behaviours that generate learning. Interactive multimedia materials can enhance learning, but the learning experiences they offer must be well understood by both designers and teachers if they are to succeed in doing so.

Introduction

The work we describe here is a collaborative research project deriving initially from a series of projects and theses focused on how students learn through multimedia. The research question concerns the fact that educational media, such as lectures, books, tv programmes, are all narrative in form, and for good reason. A storyline provides an internal structure for a presentation, which enables the learner to derive the overall meaning. Narrative therefore performs an essential organising function for the learner. An interactive multimedia resource is essentially non-narrative in form - it is one of its key features that it offers learner choice over sequence, pace and content. This poses the central question of this research: if narrative structure is so important for learner understanding, how can a non-narrative medium support meaningful learning?
The MENO project (Multimedia, Education and Narrative Organisation) is funded by the Economic and Social Research Council under their Cognitive Engineering Programme. The acronym explicitly refers to Plato’s ‘Meno’ dialogue because it is there that Socrates demonstrates the importance of guiding structure for the apprehension of understanding by the learner, in this case, Meno’s slave. Although the encounter is meant to prove the boy’s prior knowledge of Euclidean ideas, the progression of the dialogue is driven entirely by Socrates who thereby constructs the narrative that leads inexorably towards the proof of a geometric theorem. The boy’s contribution is to offer little more than “yes”, “no”, “certainly, Socrates”. Socrates is playing the role of guide, gradually eliciting agreement with the logic of the development of the idea, without ever nurturing the learner’s own ability to develop it for himself. Could the boy be supported in his own progression of the dialogue? The learner faced with a multimedia resource is facing a resource as rich as Socrates. Can we expect them to take full responsibility for the dialogue? We do not want interactive media to take control as Socrates did, but can the learner do with no guidance or control of any kind? In this project we explore the characteristics of interactive media that would have enabled Meno’s slave to conduct his own dialogue with his teaching resource.

Affordances

‘Affordances’ is a word now in common currency in describing characteristics of the learning process. The word is borrowed from the psychology of perception, but it expresses very well the fact that there is an internal relation between the perceiver and the perceived.

“What we perceive when we look at objects are their affordances, not their qualities” [Gibson, 1979]

A researcher may describe the qualities of an educational medium objectively and accurately - learner choice, self-paced, structured index - but the learner may perceive it very differently. Our question is rather: ‘what are its affordances?’, because its qualities as perceived by the learner may be very different from our objective description.

Affordances are neutral with respect to environment and observer, or medium and learner - they describe how the interaction between perceiver and perceived works - and that is exactly what we need to understand in educational research. An affordance is

“equally a fact of the environment or a fact of behaviour” [ibid]

Thanks to J J Gibson, we have a valuable concept for describing educational interactions. Examples from everyday perception would be:
A door with a handle affords pulling
A door with a flat plate affords pushing
Examples relevant to education would be:
A book affords reading
A lecture affords listening
In each case we can see how the properties as perceived by observer create the possibility for a certain kind of behaviour. Affordances are the properties responsible for the behaviour generated. We may like to think that a lecture affords learning, but the only affordances we can be sure of are those constituting its definition - it is a vocal presentation, and thereby at least affords listening. Whether it affords learning is an empirical question. But what are the affordances for learning? And in particular, what are the affordances of multimedia for learning?

**Background to the MENO project**

One of the aims of the MENO project is to develop a theoretical framework to describe the learning process in such a way that we can clarify the role that narrative plays in an educational medium. To do this we are using observation studies of students at college and university, and pupils in schools which are using commercial CDs within the curriculum. By comparing the design features that afford productive learning activities, with those that leave learners doing little more than browsing the material, we can develop contrasting interactive multimedia designs for experimental sessions on topics the pupils are already studying. Videotapes of these sessions allow us to analyse learner talk and behaviour in order to investigate the minutiae of interactivity, and the role each interaction plays in the overall learning session. In this way we can begin to isolate the design features that afford productive learning activities.

The theoretical framework which has developed through earlier projects is used in part to drive the empirical work, the design of experimental sessions, and the analysis of data. At the most general level of description, the learning process is characterised as a ‘conversation’ between teacher and student (see Figure 1), operating on two levels, discursive and interactive, the two levels being linked by the twin processes of adaptation and reflection (Laurillard 1993).

Students’ work on an interactive resource will take place at the interactive level, but in the context of the students’ adaptation of their actions in the light of their current conceptual understanding, and their practical work will be reflected upon in order to develop their conceptual understanding. Similarly, the interactive resource, expressing the ‘teacher’s experiential environment’ is an
adaptive response by the teacher who chooses it in the light of discursive level conversations with students, and a sense of what they need to do in order to learn the topic. Again, the teacher’s reflection on what the students do during the interaction will drive their further discussions at the discursive level.

The sequence described here can be applied at any level of description of the learning process, whether it is a short dialogue with the teacher explaining something, suggesting a practical example, and commenting on the student’s performance of it, or a much more attenuated period covering several encounters, class sessions, assignments and debriefing. In the context of the MENO project, the relevant sequence runs over a period of days, beginning with the teacher’s initial introduction to the material being studied in the multimedia, the session at the computer, the students’ follow-up discussion or assignment, and the teacher’s subsequent debriefing.

Implicit in the conversational framework, as should be evident from this description, is both a time-based sequence, and a succession of iterative cycles.

Figure 1: The conversational framework for the learning process
The sequence and the amount of iteration are indeterminate, but the framework expresses a minimum degree of complexity, if learning is to take place. Following an optimal sequence through, it could run as follows:

- Teacher presents conceptual knowledge
- Student expresses partial understanding via comment, question or answer
- Teacher adapts experiential task to help student experience the concept
- Task sets goal for student
- Student adapts action plan in the light of conceptual knowledge
- Student acts to undertake task
- Student receives feedback on action
- Student reflects on interaction using conceptual knowledge
- Student further adapts action plan
- Student generates new action to undertake task
- Student receives feedback on new action
- Student reflects on interaction to develop conceptual knowledge
- Teacher reflects on student interaction to begin new dialogue
- Student articulates understanding of conceptual knowledge
- Teacher gives feedback on student’s account

This minimalist sequence of iterations of dialogue, action-feedback, adaptation and reflection allows the students to be exposed to new ideas, to link these to enhancing their practice, to improve their practice and link this improved practice to further developed understanding, and to assure the quality of their understanding. The format of the layout above is meant to show the internal structure of the sequence as a series of matched pairs operating at different levels of description of the learning process, each one completing a circuit of exchange - a series of conversations between teacher and student, between student and task, and within the student and the teacher. The narrative line of the learning session is cycles within a sequence, iterating progressively towards something like consensus between teacher and student.

This conceptualisation of the learning process underlies the approach to observation and analysis of student-computer interactions. It can be applied to all forms of teaching to decide the extent to which the narrative is teacher-led or student-led. The teacher-led form is the Socratic dialogue, the lecture, the book, where the learner’s role is essentially to follow the sequence. Good teaching of this form leads the student through that same sequence outlined above, expressing the overall message, decomposing it into its constituent parts, setting up practical demonstrations of illustrative examples of each part, relating these back to their conceptual meaning and synthesising the parts into the meaning of the whole message. The student-led form is the project, or the thesis, where the
student determines the overall goal, then goes through the same sequence of decomposition, exploration of examples, interpretation in the light of the sub-goals, and synthesis into a conclusion. From the student’s point of view, the first type of learning is ‘narrative as telling’, the second type is ‘narrative as thinking’. There are bridging forms between these two extremes, where teacher and student share responsibility for progressing the sequence. Good teachers aim for these intermediate forms that begin by scaffolding the students’ work, and gradually reduce the support until the student can conduct their own way through the sequence. Can we locate interactive multimedia among these intermediate forms, or is at either extreme?

In the light of the findings of earlier studies, that students’ learning experiences with multimedia could be impoverished and instrumental (Laurillard et al, 1994), the project set out initially to test the use of CDs in schools in the light of our hypothesis that the narrative form of the learning session was critical to learning. Were these CDs ‘telling’ or ‘enabling thinking’? To what extent were they capable of scaffolding the full complexity of the learning process, as understood from the conversational framework?

Negotiations with schools using multimedia in the classroom enabled the fieldwork to be conducted in the full complexity of genuine learning tasks. It was essential that the students we studied should be engaged in a process that from their point of view was real learning, not a laboratory exercise. Teachers co-operated by arranging for our studies to be conducted at the appropriate point in the delivery of the curriculum, by briefing their students and setting realistic tasks for use with the CDs, and by following through into debriefing or assessment of the students’ work. The top-level description of the narrative sequence was therefore complete - the teacher presents the conceptual task, and comments on the students’ work on it. But what happened in between?

Methods

Videotapes of students using the CDs are transcribed, and analysed using specialist software. Evidence of the nature of the learning experience from the students’ point of view comes most directly from their dialogue as they work. In the analysis of student dialogue we look for evidence of attention to each aspect of the conversational framework: the overall goal, the intermediate sub-goals, the actions appropriate to them, interpretation of feedback, relation of this to the sub-goal, articulation of the synthesis in terms of the overall goal.

Studies were carried out with students using commercial CDs in order to capture the nature of the experience from their interaction between each other and with the program. Analysis of the interactions showed that students’
manipulation of the interface tended to dominate their talk with the effect of making the operational components of the task figural. Taylor et al have distinguished between the ‘task semantics’, which refers to the implicit knowledge students use to understand the task, and the ‘task syntax’, the aspects of the interface which students operate in order to address the task semantics. In some activities the two are seamless, where the affordances of the task syntax match the requirements of the task semantics - as in, for most of us, using a pen to write a message. In such situations the syntax remains ground to the figural semantics, as it does in the context of language itself. For the students we were observing the task syntax level was figural. This meant that any possible narrative line being constructed either by the teacher or by the students themselves was continually disturbed by the difficulty of making the transition from one cycle in the conversational framework to another. If they managed to decompose the overall task into a constituent sub-goal, the task syntax involved in meeting that sub-goal was so difficult to operate that attention became focused on that, and they lost the thread of their own narrative.

To explore the extent to which we could assist students in the process of maintaining a narrative structure for their work, we designed an interactive multimedia program in the light of the theoretical framework. For each component of the narrative outline above, the teaching method has to offer support of some kind. In the classroom it would be the teacher’s questions and instructions. In a stand-alone teaching medium it suggests that students need scaffolding of the following kind:

- a clear statement of an overall goal - to initiate a plan
- continual reminders of the goal - to support keeping to a plan
- index of sub-goals - to provide a choice of relevant activities
- multimedia resources - as alternative presentations of the material
- interactive activities - to provide adaptive feedback on actions; to motivate repeat actions to improve performance
- an editable notebook - to enable students to articulate their conceptions
- a model answer - as feedback on their conceptions; to motivate reflection on their conceptions

The new program was designed to include all these features. The same observational studies were conducted with the new material under the same kinds of contextual conditions, and videotapes of the session were again transcribed for analysis.
Findings

Comparing the pupils’ discussions for the two different types of interactive multimedia, the commercial CD resource disc, and the experimental ‘scaffolded’ disc, we found marked contrasts in the learning experiences afforded by the two discs.

In the former session the pupils’ dialogue was entirely operational. The focus of their attention was all on the task syntax, the navigational aspects of the interface. Most alarming of all, we found that even after they had watched material with a powerful emotional impact (newsreel of the aftermath of nuclear bombing), they continued to be focused entirely on the process, on the operational aspects of the task in hand. Even though this was material that was highly relevant to their overall goal, which was to investigate nuclear bombing, and was highly engaging material, yet it appeared to afford no productive response of any kind. There was no sense whatsoever of a storyline to the pupils’ investigation, no goal in sight, no progression towards it, no sense of achievement.

After seeing many such episodes in our observation of learners using these kinds of discs, the experimental versions were designed explicitly to support the learners in maintaining their narrative line more successfully, attempting to afford the activities that would help them do this.

For the contrasting ‘scaffolded’ disc, pupils were asked to investigate the causes of variation in wildlife on the Galapagos islands. Once again, there were extensive, indexed media resources, but there were some additional features as well: the overall task is stated by the medium, there is a notepad available for pupils to record their findings, and there is a model answer available once they have completed some work. In these sessions, the focus of the learners’ talk was much more task-oriented, discussing what they had found, and whether it was relevant to their goal. Furthermore, after watching a section of video, the talk remained task-focused. This time the learners were considering the relevance of the material to their current goal, struggling to articulate their ideas, and relate them to some previous findings they had gathered.

Interpretation

How do we describe what is happening here? A narrative line in any context will have an internal structure that develops over time. In a well-organised educational session, the narrative will begin with the high level enduring concept of the overall aim, which the teacher will clarify then decompose into sub-goals, or sub-components of the high-level aim. The sub-goals would then be used to generate the actions or procedures appropriate to the
task. In the two examples above these would be: looking for information about aspects of nuclear bombing, and investigating the environmental conditions for evolution. The session would then move on to interpreting the feedback they get in response to those actions, and revising their actions as necessary - perhaps looking for additional information, or more detailed explanations. The teacher would encourage students to relate this experience to what they are supposed to be finding out, and then finish with a debriefing session reflecting on all that has gone before to return to the overall message or description of the goal. Something like that complexity of structure must be present in any meaningful learning session. The storyline will follow a structure similar to the following: where are we going? what do we need to get there? how do we do that? what do we get when we do it? how far does that help us? where have we got to? That is what learners need to do, and they need support for each of those stages. Figure 2 shows the kind of cyclical internal structure a narrative line needs for meaningful learning to take place.

The Narrative Line

![The Narrative Line Diagram]

Figure 2: Representation of the internal cyclical structure of the narrative line
Our observation of learners using interactive multimedia shows that design features can be built in to act as affordances for those behaviours. The contrasting data presented above suggests that with design features such as statement of task goal, notepad, model answer, it is possible to elicit more meaningful discussion, focussed on the task-semantics. Our hypothesis is that these features create the possibility for learners to develop and sustain their own narrative line. The goal is stated to clarify the overall aim, the relevant sub-goals are offered as choices, the menu allows learners to set up their investigations, and the data provides feedback. What prompts them to revise their actions is the knowledge that there is a model answer to be matched. What prompts them to relate what they have found to the sub-goal they are working on is the continual reminder of where they are trying to get to. The editable notebook enables and encourages them to articulate their answer, and to keep trying to refine it to better match the model answer.

Figure 3: Design features to support some of the learning activities needed to construct and maintain the learner’s narrative line
That is the crucial substructure of support that learners appear to need in this kind of session. Figure 3 shows how design features for an interactive multimedia program would support each stage of the development of the learners’ narrative.

Most commercial interactive multimedia resources, offer little more than the option choices and the multimedia data. As we have seen, that does not provide sufficient support to allow the learner to maintain all the learning activities necessary to achieve a meaningful goal. Without the appropriate affordances, students remain unsupported through the crucial stages of maintaining their narrative line, and are left with nothing other than the action-feedback pair that goes nowhere, that constitutes nothing more than browsing.

Figure 4: Design features that provide only access to multimedia data support only a limited range of learning activities: the uncontextualised action-feedback pair.
To summarise: there are learning activities we want to support in sending pupils to learn from multimedia materials. There are affordances we have found for those learning activities. If those affordances are not present in the learners’ experiences of the materials, then the learning activities they afford will be hard to observe.

**Conclusion**

The overall message of the narrative line of this paper, is that within an educational experience provided by a non-narrative medium, such as interactive multimedia, we must take care to maintain a storyline. Teachers and designers must be clear what kinds of learning activities it takes to understand a topic, and then create the affordances for those activities. We have seen that students inevitably follow the lead of the interactive environment they are working in. It is the responsibility of teacher and designer to create the environment that makes it possible for them to maintain a focus on the development of the argument:

- clarify the overall goal,
- provide continual reminders of the goal,
- help learners define their own sub-goals,
- motivate their own articulation of what they know,
- motivate them to refine it,
- enable them to assess the extent to which they are achieving the goal.

These contributions from either teacher or designer constitute the engine that drives the learner through the continual iterative cycles of the conversational framework which is necessary for complex, academic learning to take place. With such design features, the non-narrative medium is able to afford something more than mere browsing: it will afford structured, meaningful learning. If we attend to scaffolding the students’ learning by providing these features we can be more certain that interactive multimedia will indeed enhance learning.

**REFERENCES**

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