Hypermedia in Education: children as audience or authors?

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ABSTRACT When teachers reflect on their teaching, their most lasting memories are when students have struggled with knowledge and constructed their own understandings, discovered relationships, and articulated original ideas – original, at least, in the child's perspective. Teachers want students to build a relationship with information, to analyse and critique others' ideas and then invent and develop their own understandings. Teachers want students to experience the joy of discovery and the pride of creativity. Our experience and that of other researchers and classroom teachers has shown that using hypermedia authoring tools in the classroom can be a powerful stimulus for students to engage in this type of learning.

What is Hypermedia?

Hypermedia refers to a unique kind of software environment that combines the characteristics of both hypertext and multimedia. The term multimedia has been around a long time, long before computers, but today it is usually used to describe the integration of text, graphics, animation, sound, video and music in an interactive software environment (Turner & Land, 1994). Hypertext, a term coined by Ted Nelson in the 1960s, refers to an environment in which we can jump around electronically within large amounts of text, following tangents that reflect our interests and bypassing information we deem irrelevant. Hypermedia extends this concept to include other forms of media, such as pictures, sound, animation, and video.

In print media, such as books and magazines, text and pictures are organised sequentially with one topic following another. In hypermedia, information can be organised the way most people think, by association and context. Ideas and concepts – whether represented as text, sound, or images

– can be linked to related ideas and concepts. Different people exploring the same body of information are likely to follow different paths, depending on their interests and objectives.

Children as Audience or Authors?

Children today are using hypermedia for learning in two distinct ways: as audience and as author. As the audience of hypermedia, children use, explore, and interact with hypermedia environments developed by others. For example, multimedia encyclopaedias such as *Encarta* and *Grolier's*, CD-ROM books such as *Just Grandma and Me*, interactive adventure games such as *Myst*, and information on the World Wide Web are types of hypermedia environments. In these hypermedia environments children are able to choose their own paths through a vast repository of information – not only text but also pictures, sound, animation, and video – by following links to related topics. The most engaging environments are highly interactive with a high level of learner control, requiring more of the learner than simply reading text and clicking on words or pictures. Although in such applications a child can explore and learn in a variety of ways, the learner is nevertheless constrained by the content and design decisions made by the software designer, whether that designer is their classroom teacher or a professional instructional designer.

The second way in which children use hypermedia is as authors, designers, and creators. As authors, children develop their own hypermedia projects. They conduct research on the topic, identify the relevant data, select supporting visuals, design the layout of text and graphics, determine how the information should be linked, debug problems, consider the nature of the intended audience, solicit feedback about their work in progress, and share their final compositions with others. HyperStudio, HyperCard, Multimedia Scrapbook, SuperLink, and MicroWorlds are examples of hypermedia authoring tools used in schools today.

Students are also beginning to develop hypermedia documents on the World Wide Web with Web page development tools such as Adobe Page Mill and Claris Home Page. There are many parallels between hypermedia authoring environments and Web authoring. However, since our research and experience has been with children and their teachers using HyperCard and HyperStudio, we will focus in this paper on hypermedia authoring tools that are not Web-specific.

Several research studies provide evidence that the most powerful learning occurs when the students are the authors and designers (Brown, 1992; Carver et al, 1992; Turner & Dipinto, 1992, 1993, 1995). Classroom teachers agree that the one who creates the hypermedia document learns more about the topic than the one who ultimately uses the finished product (Milton & Spradley, 1996; Monahan & Susong, 1996; Scholten & Whitmer, 1996; Skillen, 1995). In addition to content, student authors learn to use new technologies and to communicate effectively in a new medium that is visual, dynamic, and interactive.

Philosophically, this second way of learning through hypermedia is grounded in a constructivist view of learning. As hypermedia authors, students are empowered to construct their understanding of the content and to communicate it to others. Students become “novice epistemologists” – young scientists, young historians – not simply consumers of the analysis of the work of such people (Papert, 1990). Learning results from the interactions as students accomplish a meaningful task. The role of the teacher is to assist students in understanding how to conduct research, what constitutes evidence and knowledge, and how to communicate it effectively.

Hypermedia as a Medium of Communication

Like word processors, desktop publishing software, and desktop presentation software, hypermedia authoring software is a tool for communicating one’s ideas. How is hypermedia different? With word processors and desktop publishing, authors create static documents intended to be printed and read on paper, while with hypermedia and desktop presentations, the documents are meant to be viewed on the computer screen. Documents meant for viewing on the screen can be dynamic, involving animation, video, and sound. In addition, hypermedia can be interactive, giving the user opportunities for input. Finally, documents created by word processing, desktop publishing and desktop presentation software are linear, while hypermedia and Web documents involve links that branch to related ideas or provide more detailed information about a topic. Clearly hypermedia documents can be more complex in structure, and thus they provide students more options in communicating their ideas.

Creating a hypermedia product involves not only content, design and communications skills, but also problem solving skills. Authors must ask a range of questions: What is the focus or objective of my document? Who is my audience? What resources do I need – both static and dynamic? Where can I find appropriate resources? How do I incorporate those resources into my document? How should the document be organised and structured? How should the information be linked to facilitate understanding of the topic?

Authoring in a hypermedia environment also involves a new way of writing. Since hypermedia is non-linear, it encourages students to write in chunks, on a card-by-card basis, and consider later how to link the cards together. Thus, for some students the writing task is easier and more manageable than with a word processor (Turner & Dipinto, 1992).

Nevertheless, many of the steps in the authoring process are parallel to stages in the process approach to writing. Students participate in prewriting activities, create drafts of their work, conference with peers and their teachers, revise, and continue through several versions of their work in a recursive process. They develop these writing skills over many years, from the time they first enter school.

With hypermedia authoring, however, we are asking students–and their teachers–to learn new skills in visual literacy to enhance their ability to communicate clearly in this new medium. Writers in all media are concerned with the style and grammar of a composition as well as with its content. Hypermedia authoring involves not only content, style and grammar, but also elements of visual design.

Visual Literacy

Visual literacy involves the ability to think, learn, and communicate through visuals (Bacca, 1990). Handler et al (1995) recommend that teachers discuss elements of design and visual literacy with their students when implementing hypermedia projects. Throughout each day children are bombarded with visual messages. One of the powerful experiences for students working with hypermedia is that they develop a sense of how to communicate using visuals and how to critique the meaning and impact of visuals in the work of others.

Student authors learn how to create original visuals with graphics software, digital cameras, scanners, and video cameras as well as how to search for visual information on the Web and in print resources. Students learn and apply the elements of well-designed displays of information, such as simplicity, clarity, balance, shape and form, and the use of colour. Since hypermedia is a dynamic environment, student authors also need to consider what options to give users in navigating their stack in a meaningful and consistent way.

Visual Tools for Constructing Knowledge

Visual tools are powerful tools for constructing knowledge. They help learners see patterns and define relationships. Wandersee (1990), in analysing the connection between cartography and cognition, has identified four purposes of map making as a tool for learning: (a) challenging one's assumptions, (b) recognising new patterns, (c) making new connections, and (d) visualising the unknown. These same purposes may be applied to other kinds of visual tools that learners use to analyse and construct knowledge. Hyerle (1996) recommends that teachers not only use teacher-created visual tools to illustrate relationships and patterns, but also "provide learners with concrete skills, strategies, and tools for seeking cross-discipline patterns on their own" (p. 12).

In our work, children have used three kinds of visual tools in addition to hypermedia authoring software: concept maps, schematic stack maps, and storyboards.

Concept Maps

Concept maps help to focus the learner's analytical processes and require a learner to analyse material at a deeper conceptual level than would normally occur in reading about a topic or discussing it (Mayes, 1992). A summary of research on concept mapping has shown that it has generally positive effects on both student achievement and attitude (Horton, 1993). By requiring the learner to organise and manipulate the content, concept mapping leads to active and durable learning of the information.

Concept maps are used as a brainstorming tool in the pre-authoring stage or as an analytical tool to represent the relationships among the concepts when a stack is completed. For either purpose, students may draw a concept map by hand or with the aid of software such as Inspiration. For example, at the conclusion of the Hypermedia Zoo project (Turner & Dipinto, 1995) students created concept maps to show what they had learned about their mammal (see Figure 1). Concept maps do not necessarily show how the information in a stack is organised and linked, but rather how the information is organised in the student's mind. The advantage of concept maps is that they are truly non-linear; the components of the map may be added in any order anywhere on the page as long as they are linked appropriately.

Figure 1. Concept map created by a sixth-grade student describing her observations of a monkey.

Schematic Stack Maps

Stack maps, also referred to as linking charts, are typically developed after a stack is completed as a navigational aid for users. Stack maps show the cards of a stack and how they are linked to each other. Stack maps reveal the structure of a stack, whether it is primarily linear (Figure 2a), a tree structure (Figure 2b), or a more complex web structure (Figure 2c).

Figure 2a. Stack map of a linear stack.

Figure 2b. Stack map of a stack with a tree structure.

Figure 2c. Stack map of a stack with a complex web structure.

For children, stack development is a fluid, changing process. Although they may start with a plan in the form of a storyboard, they make many changes and revisions in their plans as the project develops and as they gain more facility with the software and its capabilities. Thus, young authors typically wait until their stack is finished to create a stack map. Sometimes the schematic map takes the form of a menu card where users can click to go to various parts of the stack. Other times, the stack map serves as a help card to show users where they are in relation to the whole stack.

Storyboards

Since hypermedia compositions typically involve a branching structure and multiple forms of media, they require new visually-based planning strategies. Storyboarding is one kind of visual planning tool. A storyboard is a screen-by-screen representation of a stack sketched in advance as part of the planning process. A storyboard shows the objects on each card – such as graphics, text, and buttons – and their layout. Both student authors and professional instructional designers develop storyboards to seek feedback about the design of their proposed project and to guide their work in the actual development of the project.

The Hypermedia Zoo: an example project

One example of students as hypermedia authors is the Hypermedia Zoo project. Over a five-year period Turner & Dipinto (1992, 1993, 1995) documented the curriculum-based project in which seventh-grade students used HyperCard to create multimedia research reports about mammals as part of the science curriculum. Each student observed, recorded, and illustrated the physical characteristics, locomotion, and behaviour of a specific mammal during four field trips to a zoo. Then they determined what information to include in their report, organised it into screen-size cards, linked the cards of information together in a meaningful way, and presented their report as a multimedia document incorporating text, scanned graphics, video-disk images, recorded sound, and QuickTime movies. In brief, the findings from the Hypermedia Zoo project indicate that the time students invest in learning to use the software and hardware not only gives them a powerful new medium of communication but also gives them new insights into organising and presenting information. Furthermore, hypermedia authoring facilitated engaged learning, peer collaboration, and promoted and validated students’ self-esteem.

The Role of the Teacher

The teacher has a multifaceted role during this time. He or she serves as coach, organiser, design consultant, resource manager, editor, evaluator and audience. This is no easy task. In addition the teacher must be familiar with the software to help students explore and experiment beyond the minimal features. Teachers who have implemented hypermedia projects in their classroom feel that the extra time and effort is worthwhile because of the positive impact on student learning and engagement.

Teaching with a new medium adds another level of complexity to the teacher's task. The teacher needs support, not only in acquiring new skills and knowledge, but in taking the risk of trying new instructional strategies. The teacher will be more successful if the school culture honours risk-taking and supports experimentation.

Supporting Classroom Teachers

Marianne Handler's research has examined the kind of support teachers need to become co-learners with their students as hypermedia authors. The first project involved a third-grade teacher, already comfortable as a technology user, who wanted her students to create hypermedia projects but was unfamiliar with the software available for young children (Handler, 1992). The teacher chose the curriculum area and the basic design of the project. Pairs of students collaborated using information they had previously researched about an animal's habitat, feeding habits, and other interesting facts. The team of two students created an imaginary creature combining the characteristics of their two individual animals. For example, one team created an "octoquin" with features of an octopus and a penguin. The teacher gave the students extended periods of time to learn the HyperScreen software, create cards with original graphics, link the cards, and seek and provide peer feedback on effective design elements discussed in class.

At the beginning the researcher's support was geared toward helping the teacher and students learn the software and helping the teacher focus on it as a curricular tool. The content of the project was, from the beginning, the responsibility of the teacher. The researcher was present at all sessions in the lab and joined the class during the stack evaluation sessions. Together the teacher and researcher developed guide sheets to help the students use the software. By the end of the project, the teacher had become comfortable enough with the software to recognise areas where this kind of support was needed and began to design her own student support materials.

Initially the teacher was ill at ease in the computer lab. Her unfamiliarity with the software made management difficult because she was unable to give the students the help they needed. Her own exploration of the software helped her recognise the value of free exploration for the students. For the teacher, exploration triggered ideas of how else she could use it in the curriculum. For the students, exploration triggered ideas on what their imaginary animal might look like. The second year was the turning point for the teacher. She had had sufficient support during the first year that she was now able to focus on both the curricular aspects and the ways in which she could provide assistance as the new group of third-graders learned the hypermedia program.

For the teacher, a critical factor in her success was having the researcher's support on an 'as needed' basis as she risked trying this innovation with students. The researcher followed the lead of the teacher in determining the amount of help needed. Although the researcher continued to be available during the second year of the project, she became more an observer than a participant observer.

The second project (Handler & Cederland, 1994) involved a fifth-grade teacher who wanted to put 'her toe in the water.' She was not comfortable using technology in her classroom although she owned a computer and used it for word processing. She and the computer co-ordinator planned a collaboration not unlike the one in the earlier project. The teacher selected a project on endangered species in which each student communicated their research about an animal and suggestions for saving it. At the beginning of the project, during the students' early exploratory sessions, the teacher walked around the lab and watched the children but did not touch the computers. At all times, however, she was involved with them in discussions of the content of the project.

As time went by, she began to sit with a student and watch what they were doing, and soon she was helping others. She came into the lab on several occasions to explore the software herself. As she became more comfortable with it, she was better able to help the students. She met regularly with the computer co-ordinator and became more involved in helping to design the student support materials, which in fact were also very helpful for her. At the conclusion of this project the classroom teacher identified specific parts of the experience that were important for her. First and foremost was the recognition that she would never have been willing to risk this kind of project on her own. The knowledge that it was a team effort between the computer co-ordinator and herself and that help was always readily available was important. She listed other elements of the experience that were also important for her: she learned the software, she increased her comfort with technology, she developed new ways of thinking about students and learning, she became aware of students' needs as technology users, and she became a learner also.

Conclusion

In this paper we have discussed cognitive tools that aid young students in designing and authoring hypermedia compositions. With hypermedia authoring software, which is itself one kind of cognitive tool, children become software authors rather than the audience. As authors, they develop their own hypermedia compositions. In the process, they learn not only about the topic of their composition but also about the elements of design that are important for communicating effectively in a visual environment. Representational tools such as concept maps, stack maps, and storyboards help students analyse the relationships among the sub-topics and plan the navigational structure of their document. The overall process of developing a stack helps learners analyse what they are learning and think about their own cognition.

Jones et al (no date) contend that the only real measure of the effectiveness of new technologies in learning is the extent to which they promote students' engaged learning. When students decide on projects that are personally meaningful to them and set their own goals, they become powerfully engaged in learning. They are energised by learning and consider learning fun. They are reluctant to interrupt their work when the school bell rings. Students reflect on the structure of knowledge as they work on hypermedia projects. They make connections at different levels – mental links to associate one idea with another – and are able to construct concept maps and linking charts to illustrate the structure of the information.

The teacher's role is a critical one in establishing a learning environment that supports student authors. The authoring tools that promote student engagement in complex, sustained learning projects are often new to teachers as well as to their students. If these tools are going to help students become curious, motivated, engaged learners, we as teacher educators must develop a commitment to support teachers as they become engaged as co-learners alongside their students. Collegial support, from co-workers and administrators, may well be the key to taking full advantage of the software tools described in this paper.

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