HYPERTEXT DESIGN AS A LEARNING TOOL

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Abstract

For students to become thinkers and problem solvers, we need learning in which these goals are key. Two hypertext concepts, non-linear thinking and interactive reading, provide powerful ways to evolve and present factual and analytical content meaningfully, even if it is never computer generated. When students view a topic from multiple perspectives and organize information in a diagram, they see breadth and inter-relatedness. The learners can also make reader-friendly designs. Readers become learners, constructing understanding by traversing the diagram, guided by their own needs. Diagrams are tools too for teachers guiding exploration. Creating non-linear content reflects our thinking [4,7], as we can incorporate tangential thoughts, later recollections and items we may later discard. The results are substantial documents of information and underlying concepts, models of many ways to organize prose and opportunities for teachers and learners to construct and convey meaning.

1. More effective learning strategies

Almost everyone agrees that information technology is an essential component of an educational system proposing to help youngsters become learners and to prepare learners for academic, professional, civic and social challenges. Underlying the technology most appealing to today's school age population, multimedia programs, lies a key to more effective learning strategies that has not yet been fully considered. That key is hypertext design.

1.1 Identifying useful hypertext characteristics

Two fundamental hypertext concepts, non-linear thinking and interactive reading, provide learners and teachers strategies for eliciting, evaluating, developing, organizing and presenting factual and analytical content. We have become accustomed to seeing these two hypertext concepts carried to their usual conclusions, web pages and CD-ROM's. Electronic games players use these concepts to make the decisions that carry them through the intricacies of the fantasy worlds of their games. We can also use non-linear thinking and interactive reading to create challenging and rewarding learning environments - even if these environments do not include the opportunity to develop content into actual multimedia programs.

1.2 Moving from passive to active learning

It is the kind of thinking processes and problem solving reflected in hypertext design that provides an opportunity for students to move away from passive learning. They need not be overwhelmed by a myriad of facts and ideas delivered by teachers, information items sometimes seeming to exist in isolation from each other and too often unsupported by the evolutionary thinking that brought the information into being. Collecting and attempting to memorize facts validated because they are pronounced by the teacher is not the same as learning. Yet, until recently, it was the guiding principle for most American education. As J.G. Brooks and M.G. Brooks point out, education has traditionally been "premised on the notion that there exists a fixed world that the learner must come to know. The construction of new knowledge is not as highly valued as the ability to demonstrate mastery of conventionally accepted understandings" [3]. Mayer noted in the early 1960's: "If the child cannot give back on demand what he has been taught, it is assumed that he has not learned it" [8].

This kind of top down delivery does not encourage learners to consider a variety of points of view and to come to conclusions based on evidence derived from personal investigation. Not only do schools risk producing unimaginative, bored and passive members of society, but schools that deal exclusively in top down education risk fostering intolerance for different points of view and acquiescence in authoritarian structures. This runs counter to a democratic ethos which many societies contend is the spirit they desire in their citizens.

Jerome Bruner told us in 1971: "A method of instruction should have the objective of leading the child to discover for himself. Telling children and then testing them on what they have been told inevitably has the effect of producing bench-bound learners whose motivation for learning is likely to be extrinsic to the task - pleasing the teacher; getting into college, artificially maintaining self-esteem" [5].

Moreover, only collecting traditionally accepted information does not suffice to prepare most people to take on the roles and tasks of responsible and vibrant adulthood. If we are to provide enabling education that encourages learning designed to develop independent thinkers and creative problem solvers, then we need

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school learning environments in which active, student-centered learning provides the practice needed for learners to become lifelong discoverers and genuinely productive members of society.

Moving from an emphasis on learning decontextualized information to a focus on grasping underlying concepts from information in context is a foundation of the Constructivist movement in education [3]. The Constructivist philosophy is beginning to gain acceptance in sectors of the educational community. Constructivist speakers and workshop presenters are active at education conferences and workshops. A body of teacher-friendly literature is available, and practical materials for classroom use are in the catalogs.

Practical materials can be both a boon and a handicap. As starting point models, these materials are often fine. As "fill in the blanks" exercises, they are not. If we want to help youngsters become active learners we, as educators and parents, need to encourage youngsters to be active creators of the their own conceptual understanding.

In this paper I propose to examine the concepts of linear and non-linear thinking and various ways of enabling readers to actively engage with the information they encounter. I will also present some examples of hypertext design used as vehicles for learning. Throughout I will be reflecting on how non-linear thinking and interactive reading can make a significant contribution to the creation of a challenging, authentic learning environment.

2. Using linear and non-linear thinking

Many adults today probably have painful memories of learning the following method of outlining:

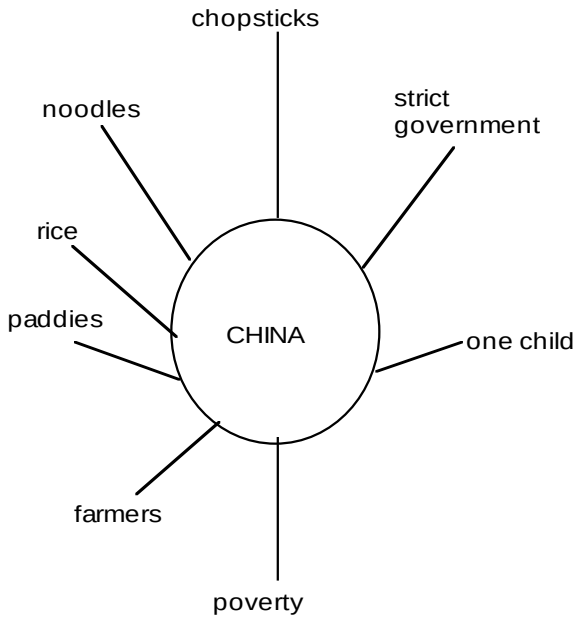
I.
  A.
    1.
    2.
  B.

You may also remember such little phrases as 'If you have an A, you must have a B,' and 'All letters and numbers must be followed by periods.' Hyerle calls this "[t]he unbearable task [7].

This kind of outlining could be used (according to some teachers, had to be used) to prepare English and history essays. Indeed, preparing the outline was considered a critical preliminary element in the preparation process and was often read and graded before the student could proceed with the essay. Given how much this outlining method has been valued in the United States and how many of today's teachers had to use it as students, it would be surprising if there were not teachers still promoting it today.

For students preparing outlines by this method, the first crisis comes when they have thoughts that don't surface at the appropriate point in the outline! How can new material be added? At this point, some students will just take the route of least discomfort. They simply do not add their new thoughts. The task appears too onerous - and it is. Students using computers can insert and then make adjustments in the Roman numerals, capital letters, numbers, small letters, numbers embraced by closed parentheses and small letters embraced by closed parentheses. With the proper software, this can be done by the computer. (Imagine the pre-computer days when introducing changes meant starting over, because one was not allowed to write with erasable pencil!)

The need for so much focus on accurate form detracts from attention to the substance the learner is supposed to be considering. Moreover, this linear method of collecting and organizing one's thoughts does not fully or adequately respond to the usual thinking style of the learner. Human beings do not generate thoughts in the linear fashion of an old-fashioned outline. We have tangential thoughts, recollections of useful material at various times, free associations and associations generated by a huge range of stimuli. For the student who is asked to organize thoughts in order to write a document, there is a welter of seemingly ungovernable information from outside sources and inside one's head. In short, we are non-linear thinkers by nature [4,7].



ACTIONS: Add to this diagram. (Encourages active reflection on what students already know)

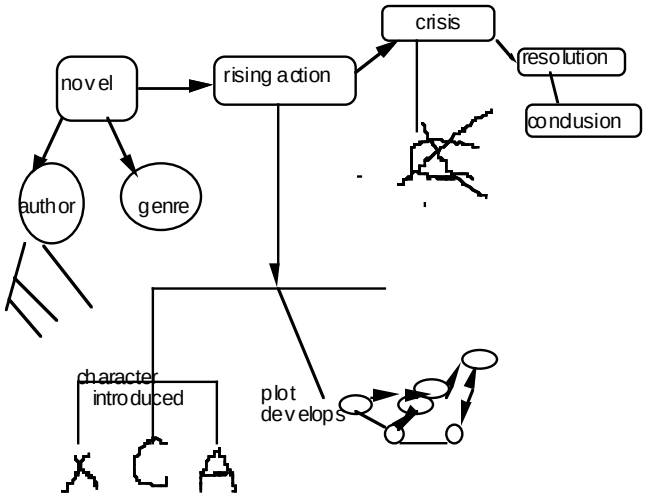
Look for additional ways to connect the information in the spider web. (Leads to creating a relationship diagram)

Figure 1. Spider web: Pre-study brainstorming: What do we already know?

Many elementary and middle school teachers have known this for years - and have found effective methods for helping students to impose some non-linear design on their thoughts. They use various kinds of diagramming strategies, including"spider web" brainstorming (Figure 1), relationship maps (Figure 2), story maps (Figure 3) [3,7], semantic maps (Figure 4) [2]. and concept maps (Figure 5). It can be said that these teachers have been dealing with simple forms of hypertext designs. Hyerle, in *Visual Tools for Constructing Knowledge* has gone several steps farther with diagramming, by creating a flexible language of graphic tools for varied kinds of tasks and communications [7]. I anticipate using aspects of this graphics language with students in grades five through eight to see if codification of graphic symbols is effective or if the code becomes an end in itself for current students, as formal outlining did for students of my generation. Using the software that offers this language may be an additional way to learn more about its impact.

Even without the benefit of computer support, elementary and middle school children have been developing and presenting multimedia renderings of spider webs and story maps for some years. Color, yarn and other materials, oral reporting, drama, singing and other forms of music are all media school children use to convey to their peers and teachers what they have learned.

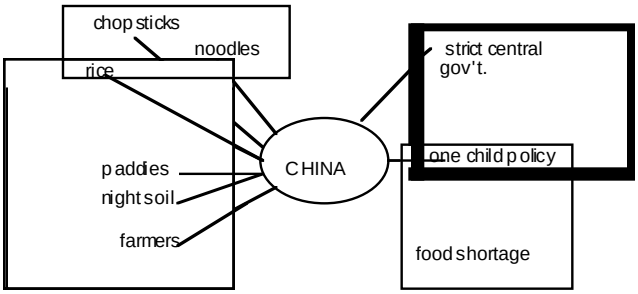
3. Empowering students with hypertext design



ACTIONS: Use several entry points to reading this diagram? (Diagramming as hypertext design)

Follow various routes through the content of the diagram.? (Reader as author)

Figure 3. Story map: Simple narrative flow that can be expanded in breadth and depth



QUESTIONS: How does clustering related pieces of information help make sense of the content? (Addresses metacognition)

Are there other clusters? What else do you need to know?

How can the relationship diagram help writing? Talking to others? Giving a report? (Diagramming as a process tool)

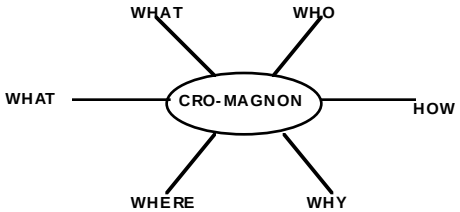
Are there several paths through the information? (Diagramming as hypertext design)

Figure 2. Relationship diagram: Seeing connections among pieces of information

Making hypertext design a tool in the learning process makes demands on students for active participation. It also empowers them by creating environments in which their particular learning style and their particular take on collections of information and concepts have relevance. As decision makers creating their own understanding of new knowledge, they are likely to have a more vested interest in discovery and learning.

4. Teacher as author vs. teacher and students as co-authors

When teaching, I sometimes put a hypertext diagram on a whiteboard to introduce the day's lesson.. In a more traditional teaching mode, the instructor would use the diagram to underscore explanations during a class lecture. However, that mode is much too teacher-



Note: In this California History-Social Science Project activity, students working in groups are asked to use this diagram to record what they know about Cro-Magnon people after reading an article on the topic. They are then to use the semantic map to write a newspaper article about the discovery of a prehistoric piece of art.

Figure 4. Semantic map

centered and requires passive students who copy the diagram without having to give its content much thought. One provocation to activity is to turn the lecture into a discussion that is guided by an initial, skeletal diagram that only introduces the content. For example, the design may only include top level information. As students expand upon and begin to see relationships among the points noted in the design, the instructor adds the new content students are introducing, based on previously assigned reading or their own prior knowledge (Figure 5). Thus, teachers and students become co-authors.

At this point it may be tempting for the teacher to take the initiative to place the new information on the diagram. That allows a relapse into passivity. Instead, students should be asked where the new information should go. Hopefully, this will trigger off debate as students see different or multiple locations for the new information. You may hear one student say something like 'It goes with economics...no, with politics...oh, maybe with politics, economics and social hierarchy. Can I put it in all the places?....Maybe it needs to have a node of its own...maybe...' Now students are thinking about the relationship among segments of a topic or the relationships among several topics. They are striving to construct meaning through the creation of a diagram.

4.1 Achieving outcomes through co-authoring

The outcomes in this kind of situation are multiple. First, students are actively considering the subject matter. They are beginning to see that there can be many ways of thinking about the subject matter and that it is not always necessary that one way prevails. This is not to be endlessly relativistic. In fact, part of the organizational design of the subject matter in the diagram should convey that there are assertions being made and evidence being offered. Where there is no evidence or no relationship to other elements of the content, the assertion is not likely to survive.

4.2 Introducing new topics with hypertext diagrams

This kind of hypertext diagram can also be used when a new topic is being introduced. Many teachers, particularly when dealing with younger students, begin a new topic by having each child express what they already know, and then what they want to learn or what interests them about this topic. Traditionally, what results is a large array of topics written out on a board or transparency in no particular order. While this can help the teacher figure out what areas of the topic to go on to present, the outcome is often bewildering to most students. Making students authors in introducing and organizing the topic makes them active, invested participants from the outset.

4.3 Limiting the role of the teacher

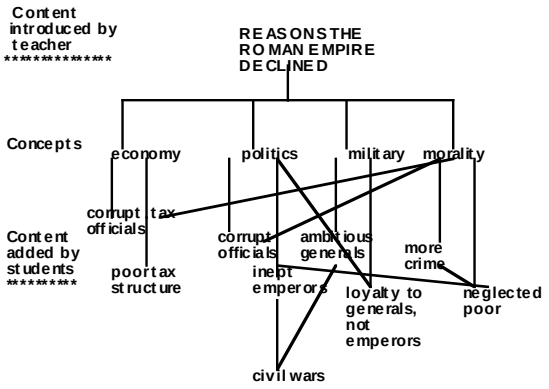
Students can become even more active in this introductory phase when the role of the teacher as co-authoris limited. Once the teacher has established the broad parameters, students working in small groups can create their own diagrams. Groups can then compare diagrams, thereby discovering the variety of ways one might encounter and explore this subject matter.

4.4 Recognizing other products of diagramming

Other outcomes of diagramming include a useful structure from which to construct a document. In some cases students may be able to turn their design into a web site. However, the diagram is equally useful as the non-linear outline for writing a linear essay. The bonus is that the essay may be organized from a choice of perspectives arrayed before the author. Ideally, students will be able to shift away from the "state a thesis and defend it" mode to consider a variety of theses reflecting multiple points of view, which can be defended with varying success. The author is then turning readers into active participants who must consider the array of possibilities before them and hopefully reflect on the multiple offerings.

4.5 New models for presenting traditionally linear content

Open minded teachers can go further and help youngsters discover that not all of every essay and report has to be presented as linear text. However, I have found that some students are so wedded by years of training to linear presentations that they need reassurance and examples of non-linear presentations to liberate their thinking. Once freed of linear constraints, students can use their diagrams to create three dimensional and multi-media presentations, using a variety of materials. One way



Note: Diagrams that become complex are more easily read if color-coded.

Figure 5. Concept map: Teachers and students as co-authors

to encourage creativity in presentations is to have handy a variety of materials and recycled "stuff" that may be incorporated. Most youngsters have great ingenuity in turning diagrams into poster reports which allow readers to choose from various paths through the report. They may also design ways to make several parts of the text available the same time, by developing multiple layers of content that can be viewed or heard simultaneously.

5. The learner as the 'reading author' a.k.a. the 'authoring reader:' making sense of conveyed content

What if the content is more sophisticated? Suppose a teacher has used a web or more intricate hypertext diagram to give students the details of a moment in history, a related series of historical events or the interactions of the characters in a story (Figure 3). The teacher may track the progress of her ideas by indicating items on the design in the particular relationship she wishes to convey. She may go further and propose several different points of view by tracking several routes through the design. The students are thereby encouraged to consider the various "takes" the teacher has on the subject matter. This tactic is useful for modeling diagramming technique, enabling students to see the coherence the teacher has imposed on the material and how she has derived that coherence.

However, if this tactic is used only as a component of lecturing, then a valuable opportunity is lost. Though various interpretations are now available, students are allowed, or even encouraged, to be too passive to have optimal learning experiences. Why not expect the students to explore the possible logical relationships among the pieces of information? Demand that the students try to figure out what is going on. Insist that they speculate, based on the information they already have at hand. Moreover, ask them to justify their speculations with evidence. In short, have the students author their own understanding or interpretation of what they see in the diagram.

One proviso: interactive reading in which the reader is

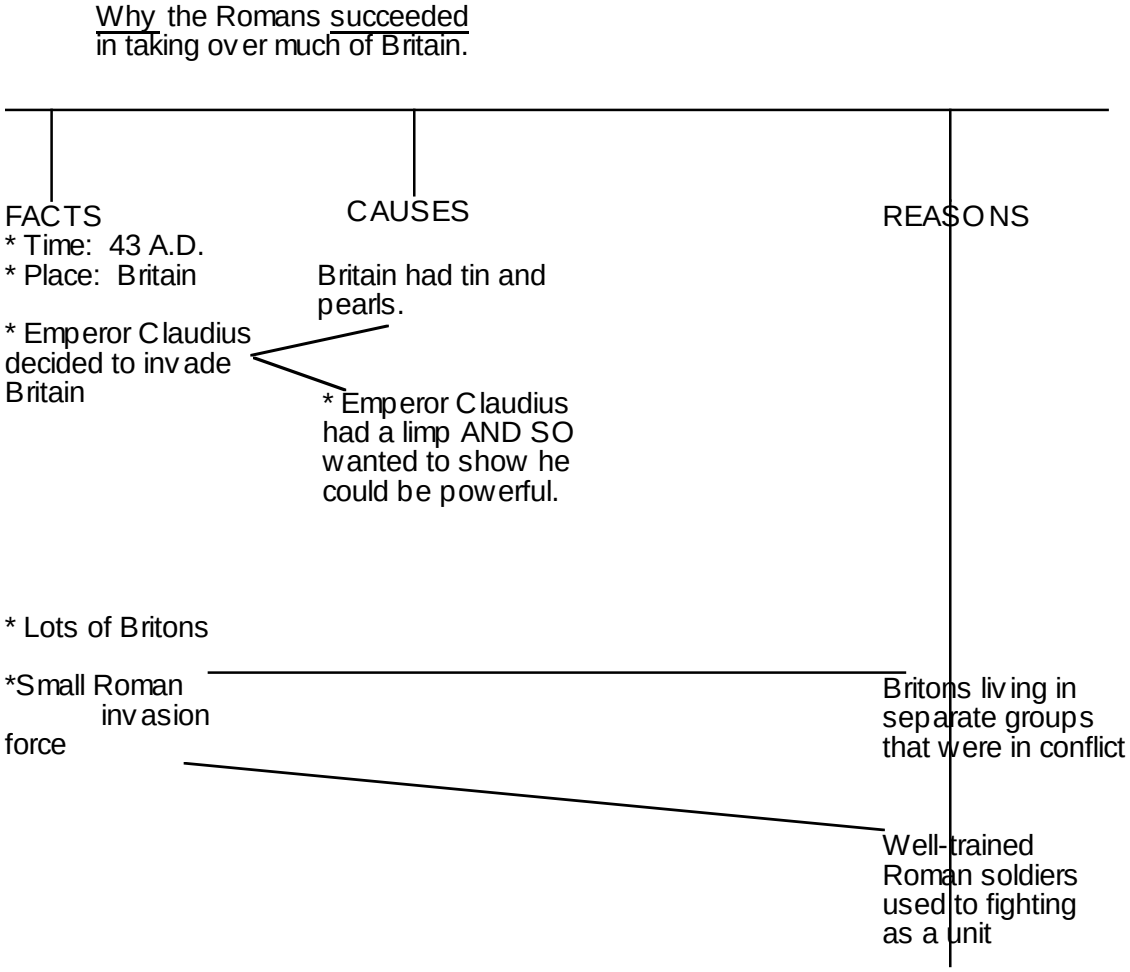


Figure 6. Organization of fact, reason and cause (using Chata Project data)

'authoring' the text by creating the relationships among the text parts is not to be an anarchic act in which all relationships among text parts are possible or valid. Teachers need to be guides, helping the 'reading author' to consider whether particular relationships among parts of a topic can be justified. Do they respond to the internal logic of the thesis? Common sense? Factual accuracy? Here is a valid moment for the teacher to become the guide through the maze of possibilities, helping the students to analyze their own speculations for validity.

For example, we can create a hypertext design depicting various reasons for the decline and eventual dissolution of the Roman Empire (Figure 5). Many of these reasons are interrelated, such as the relationship between ambitious generals and civil wars or between economic decay and the decay of moral values. However, we would have trouble justifying a relationship between Nero's excesses in the first century A.D. and the appearance of Attila the Hun at the gates of Rome in 452 A.D.

So the 'reading author' is challenged to think about the content and its interrelatedness. This makes the learner an active participant in constructing meaning, rather than a passive receptacle for pre-packaged clusters of information.

5.1. The learner as author: constructing content relationships to make meaning

Let us assume we have a classroom of students learning about the American Revolution. Their goal is to determine the range of causes of the American Revolution and how those causes may have influenced each other and acted as stimuli to subsequent events. They have been asked to read an assortment of material on this subject matter. Students encountering this history for the first time, even in a summarized version, may find it an uncharted wilderness punctuated by alien names, unknown places and dates that suggest it all happened 'a long time ago' and therefore is of no intrinsic interest. However, if they have been regularly encouraged to construct meaning when encountering new content, they will measure new content against what they already know and begin seeking relationships among the parts of the topics in light of their existing knowledge. When they have evolved an understanding of what the content signifies, the have achieved what R.N. Caine and G. Caine call "felt meaning" [6], what a learner has achieved when she or he says "I get it!" Students can be encouraged to go through a diagramming process that uses hypertext scaffolding to 'get it.' It is in the process itself that the learning occurs, culminating in "felt meaning."

5.2 The learner as author: diagramming for more complex meaning

Here is how the process might happen. Students begin with some pieces of top level information, for example, facts in a historical narrative (Figure 5). Sorting out the top level relationships among pieces of narrative information is only the first step that needs to be accomplished by diagrams. A next step is getting at the more complex relationships within the parts that further refine meaning. It is essential to go deeper than the top level if one is to avoid sloppy thinking and glib, ultimately flawed analysis. With diagramming, this is possible, even for young middle schoolers.

Each top level element of the whole content can be separated into separate strands of thought that can connect to each other in a variety of valid ways. The nature of the connections will depend on what sense learners make of the content as they explore relationship possibilities. The active process of diagramming, probably involving some trial and error, can help individual learners come to deeper understanding of their topic. Hyerle [7] reinforces my belief that even more is achieved when students share their conclusions with others. When several small cooperative groups within a classroom each take their individual diagrams and negotiate shared meaning, further learning occurs. Finally, groups might share their conclusions with the rest of the class, adding more possibilities for negotiating meaning.

In their much quoted work on learning, Novak and Gowin [9] have examined the use of concept maps as tools for learners and assessors. Their interest in hierarchical constructions would seem most valuable for later stages in the development of a presentation, after learners have recorded information and ideas using less hierarchical brainstorming webs. Top down or bottom up strictures introduced too early in the thinking process may limit the ways one may approach a topic and eliminate some avenues of thought that might be considered.

For example, students could use a fairly diverse array of information to organize the relationship of "act, reason and cause" [1]. Figure 6 shows how one might take the information gathered by the Chata Project on why the Romans were able to conquer most of Britain and construct diagrams that clarify the relationships among fact, reason and cause [1].

As the Chata Project information illustrates, it is easy to toss around bits of factual content, but the facts really do not tell us anything significant until we see how they relate to each other in particular contexts. The first step is to decide what one wants to know. Do we want: description; analysis; reason for action/consequence of action; cause of outcome and effect of outcome; chronological narrative? (I would propose that chronological narrative is superficial and usually not truly meaningful unless one incorporates reason and cause-effect elements into the telling. Unfortunately, that is not a premise readily accepted by many educators, although the advocates for constructivist, multi-dimensional learning are making inroads.)

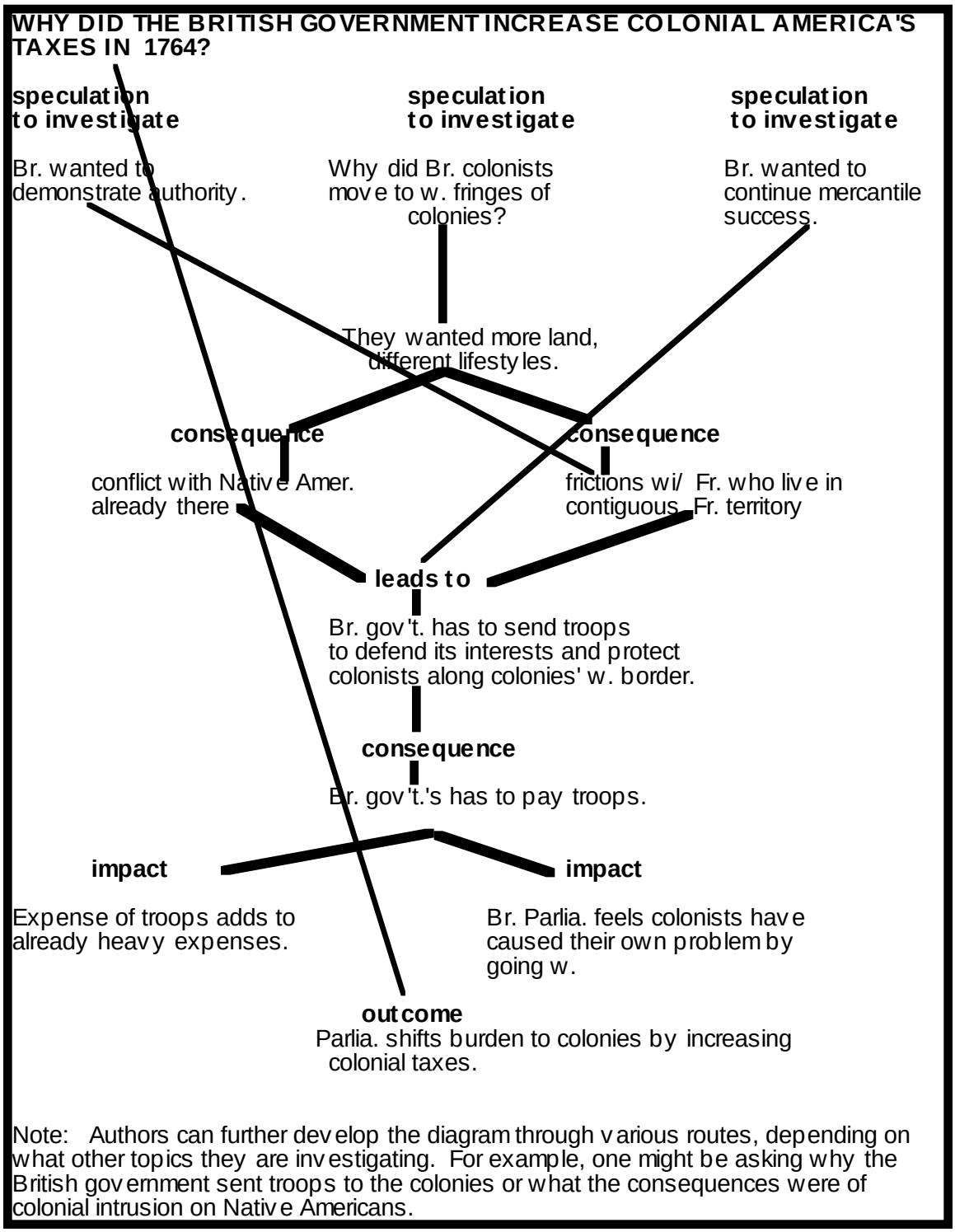


Figure 7. Diagramming as a reasoning tool

Additionally, learners should be encouraged to avoid glib conclusions resulting from glossing over the actual goals of the inquiry and the scrambling together of the elements of content in the presentation of the outcome. Stephen Toulmin [10] has pointed out the value of recognizing how the pieces of an argument relate to each other, guided by what he calls "field-dependence," awareness of the context. Toulmin's approach also

encourages useful depth of argument, by breaking down support for a conclusion into several inter-related types. This "micro-management" of content enables students to learn to argue more substantially and forcefully, both orally and in text.

Toulmin also uses diagramming effectively to clarify the elements of an argument. Just as in the Chata Project, one is obliged to embed "micro-arguments... into the macro-arguments in which they figure...," [10] if they are, in fact, relevant and valid to the argument. Applying this to diagramming in the classroom, we can persist in the goal of precise expression that derives from making appropriate connections among the elements in one's argument. Using a diagram can become a good antidote to sloppy thinking.

Let us take for example the question: Why did the American colonists revolt against the British government? To direct the learners' investigation, we could say it is important to frame the question carefully. What line of inquiry do you want the learner to follow? However, I believe it is more valuable to ask learners to figure out directions the inquiry should take. What do we need to know to understand the American Revolution? The bonus here is students invested from the beginning of the process of discovery. Moreover, once they are accustomed to diagramming as a tool for reasoning, they will begin to draw upon it , even to frame their questions.

Now let's look at a portion of the response to the question: Why did the American colonists revolt against the British government? It is easy to say: American colonists did not like being bossed around by the king of England and his parliament, particularly when they did not feel adequately represented in that parliament. When the taxes became too burdensome, there began to be acts of rebellion and eventually a full scale revolution. I would propose that this explanation is too glib even for a ten year old.

Instead we might look at historical incidences/speculations/consequences/outcomes (One could also have used cause and effect labeling.) depicted in Figure 7. Note that in Figure 7 just one issue is addressed, the increased taxes American colonists were told to pay to the British government. Many other routes could be developed by entering the diagram at different points or by asking different questions.

6. The learner as research designer: deciding what to investigate

Learners might also use diagramming as an aid to research investigation. They could begin by constructing diagram(s) that answer questions they have posed: What do we know? How do we know what we know? How does the origin of our information impact our interpretation of what we know? Having accounted for bias, learners can ask "What do we want to find out?

6.1 The learner as thesis-maker: making sense of research input

For many younger learners, research as a cooperative activity generates greater interest than isolated investigation. Research tasks are shared, with each group member preparing diagrams of resource information that are then coalesced after meaningful negotiation. This coalesced diagram should present a schema that enables the group to develop a thesis that has resulted from research. The group then diagrams a design for presenting the thesis and supporting evidence. At this point, gaps in the design will indicate where further research is needed or suggest the need for rethinking the thesis.

6.2 The learner as research presenter

In creating the presentation, the learner/researchers make the shift to become learning authors who can design a hypertext presentation based on what they have uncovered by reading source materials and doing other research. How can they convey their new knowledge so that others can follow the various trails of reasoning? They can use the diagrams as an outline from which to write a traditional essay or report. They can create non-computerized presentations. Think about how cartographers do this with maps. They use color; they use texture; they use other qualities of three-dimensionality. This can be carried out with traditional materials, such as crayons, yarn or paper mache. (Youngsters often have wonderful ideas about materials and what can be done with them.) If time and resources permit, the presentation can be done virtually, using software.

7. Redefining the role of the teacher

Encouraging students to work without their teacher would have been heresy in days gone by. Even now, when it is more accepted as good pedagogy, some instructors find it difficult to let go of the reins. The reasons are many: fear of not seeming to be the fountain of knowledge; uneasiness about losing absolute control over the learning process; and discomfort about the noise level in a room where many students are talking and arguing. A teacher may also have to explain to students and parents that creating a child-centered classroom does not mean abrogating one's responsibilities as teacher. One may even be called upon to justify one's salary in a classroom where students are busy making meaning!

However, excluding the teacher as author gives the teacher an even more demanding job. In a child-centered classroom, teachers are actively discussing, debating, arguing, questioning, researching and finding materials. Lesson plans cannot be written in stone before the class begins but must be modified daily, sometimes right on the spot, to reflect the particular needs of a variety of

learners. In addition, teachers are obliged to assess their students in ways that can be substantiated but that also honorably reflect the learning process. Hyerle [7] shares my view that student-produced diagrams are one tangible way to track a student's learning progress.

8. Conclusion

Hypertext diagramming can be modified for use at a range of grade levels. It can be used in the classroom in a variety of ways, both formally and informally, in short time frames and for more extended periods. While many schools' mandates, curriculum requirements and limited time frames can pose obstacles to open-ended student-centered learning, more and more teachers are finding ways to introduce challenging learning strategies. Hypertext design can contribute to these improvements.

Major resources for the producing hypertext diagrams lie, of course, in the design skills and intuitions of learners and teachers drawing by hand or using drawing software. (The figures in this paper were done using MacDraw by a teacher with very ordinary knowledge of the software.) However, software specifically for hypertext diagramming is beginning to become available. Hyerle [7] has noted some software for making thinking maps, including Inspiration, MacMapper and Thinking Maps: Software for the Mind.

If we expect youngsters to become adults who can meet challenges, generate ideas and solve problems, we must redefine the preparatory process for adulthood responsibilities. We must give youngsters opportunities to practice for the way they will be expected to perform. They need to develop conceptual habits of mind that will enable then to actively make meaning out of the world around them. Thinking tools, such as diagramming, can contribute to a genuinely new way of educating learners, a way that has validity when measured against what a learner must achieve to be successful in contemporary society.

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