Appendix B.   C³M Documents

Appendix B1
C³M Project: Connecting & Collaborating through Concept Mapping
A Proposal to the Lexington Education Foundation
24 March 2006

Overview

The C³M Project proposes an innovative teaching tool to shift students from rote memorization to more meaningful understanding of biological concepts. A team including Elliott Gimble (classroom teacher), Barbara Newkirk (special education teacher), and Jane Heinze-Fry (education consultant) will introduce concept mapping to diverse student populations in the classroom and resource room. Targeting key biological concepts that align with the district curriculum and state frameworks, the C³M Project will enhance student learning by emphasizing: (1) connections between the "forest and the trees" (superordinate and subordinate concepts);
(2) individual and team learning; and (3) collaboration among students, parents, and teachers.

Project Goals and Rationale:

Goal 1: To pilot and evaluate the use of *CmapTools* concept mapping software in helping Lexington High School students develop more meaningful understanding of scientific concepts.

Goal 2: To introduce a model that enhances student learning through: 1) individual and team learning and 2) increased collaboration among and between students, parents, and general and special educators.

Developing science literacy in high school students is an on-going challenge.

Many students, especially those with a learning disability or language processing issue,

often feel overwhelmed by the sheer volume of content and the complexity of the

textbook language. Many students struggle to translate the terminology and identify key

concepts, only then to confront understanding the "big picture" and interrelationships

between ideas. Some surrender to the path of least resistance: rote memory to meet the

pressing concern of passing the test.

Lexington High School is committed to meeting this challenge. The LHS Science

Department Science is dedicated to "[providing] a rich, inquiry-oriented learning experience

for all students," teaching the scientific skills and habits of mind that can "help all students to

become scientifically literate individuals who understand how science, technology, and society can influence each other." (LHS Science Dept. Mission Statement, 2004).

Furthermore, the LPS 2005-2006 Systemwide Goals recognize that faculty need "professional development opportunities tied to new curriculum and instructional implementations" if they are to "perform at the highest professional level." These goals also call for increasing "collaboration between general educators and special educators to provide a coordinated delivery of teaching skills and learning opportunities for all students" so as to "ensure that the academic, social, and emotional needs of students are identified and matched with appropriate and effective curriculum and instructional experiences" (LPS Systemwide Goals, 2005).

Toward this end, we propose a pilot project using web-based concept mapping to help students become scientifically literate while increasing collaboration and communication among parents, students and teachers. "Concept mapping" – initially coined and extensively researched by Joseph D. Novak and others (Novak, 1998; Cañas, A. J., et al, 2004) – allows users to simplify complex language by presenting concepts in a visual/graphic format (see attached examples). In this way, students can better understand and retain material and make it more meaningful. With the added capability of sharing concept maps through cyberspace, *Cmap Tools* software was developed by Novak and a research team at the Institute of Human and Machine Cognition (IHMC), a university-affiliated research facility, and is free to educators. *Cmap Tools* allows students, parents, and teachers (both general and special education) to collaborate, share results, improve student understanding, and monitor progress all through the Internet.

Project Description:

Target Population: During academic year 2006-2007, a team of Elliott Gimble (LHS Biology teacher), Barbara Newkirk (LHS special education teacher), and Jane Heinze-Fry (LHS parent and education consultant) will introduce concept mapping to approximately 50 students in two sections of non-Honors Biology and in Ms. Newkirk's resource room. These populations include a diversity of learners including those to whom the material comes easily and those more challenged who often struggle with academics and are not reached by conventional strategies. We believe concept mapping can benefit a wide range of users in diverse ways. Ultimate numbers of students served would be much higher, including those in other science classes as *Cmap Tools* and methods are disseminated through the project. (Dr. Heinze-Fry is already working with Elementary Science Coordinator Fran Ludwig to utilize concept mapping in demonstrating how the Big Backyard Program supports the Lexington Elementary Science Curriculum; beyond this LHS pilot, there is potential for additional collaboration and integration across the district.)

Activities and Timetable:

Targeting key biological concepts that align with the district curriculum and state frameworks, the C^{3}M Project will enhance student learning by emphasizing: (1) connections between the "forest and the trees" (superordinate and subordinate concepts); (2) individual and team learning; and (3) collaboration between and among students, parents, and teachers.

We propose to test the use of concept maps as a learning tool while simultaneously designing strategies for collaboration among the classroom and special education teachers and students. The project will be accomplished in four phases:

(1) The Team (Summer 2006) - The team will review concept mapping strategies, learn to use *CmapTools,* and plan how best to introduce and evaluate this tool with students.

(2) The Students (September 2006 - February 2007) - We will implement our strategy including at least two in-class applications, tailoring our proposed model based on student and teacher feedback.

(3) The Report (February - April 2007) - Gathering data from earlier phases, we will assess the use of *Cmap Tools* in the science curriculum and draft a report that includes recommendations and a finalized "how-to" manual for use by faculty.

(4) The Sharing (April - May 2007) - We will develop a report presentation/training for LHS science and special education faculty. During a joint LHS science and special education department meeting, we will share our findings with colleagues and train them in *Cmap Tools*.

Phase 1: The Team and the Tools (July - August, 2006)

CmapTools will be downloaded onto LHS computer room computers and science department laptops. As a team, we will review current research in concept mapping that addresses our questions: What are key characteristics of concept maps? What strategies can be used to evaluate concept maps? How can concept maps be applied in a classroom setting? How does *CmapTools* work? What features match the key characteristics of concept maps? Enhance the learning community? Enhance the linking of student experience to conceptual structure? J. Heinze-Fry will collect and share research that targets these questions. Resources will include books and research articles on concept mapping and other meaningful learning strategies, the proceedings of the first

international conference in concept mapping, and two websites supported by IHMC. E. Gimble and B. Newkirk will review this research, make their own maps, and learn to use *CmapTools*. Using this shared experience, the team will choose a first strategy to introduce concept mapping to their students. The team will also develop a student evaluation tool to assess and improve the concept mapping experience. The team will choose how to evaluate student individual and team maps: rubrics and/or computer comparison of "novice" maps to an "expert" map.

Phase 2: The Students and the Tools (September, 2006 - February, 2007)

For the initial unit, J. Heinze-Fry will develop a concept map aligned with the state frameworks and school curriculum, share the map with the team, and edit according to their feedback. The team will design an overview map for the students and implement their chosen strategy for one unit, which will include student-generated maps. J. Heinze-Fry will attend one of E. Gimble's classes and offer any insights. B. Newkirk and E. Gimble will collect students' concept maps and evaluations. J. Heinze-Fry will summarize and evaluate the results of this initial implementation. For a second unit, E. Gimble and B. Newkirk will design a concept map. (Students will create their own concept maps during a minimum of two units.) Questions to address include: Are the students able to create maps, individually and as teams? Are they able to create and/or search for resources that they are able to link to their maps? Does the class develop better thinking skills as demonstrated by better maps as they share their maps with each other? How do students evaluate concept mapping as a learning experience? How are educators best able to use concept mapping skills to introduce a unit and to teach concept

mapping skills? We will invite LHS's "Best Practices" student group to observe and evaluate the value of concept mapping teaching strategies during a mapping class.

Phase 3: The Report on the Impact of the Tools (February - April, 2007)

After the completion of two units, J. Heinze-Fry will consolidate maps and surveys, produce appropriate tables and graphs, and summarize our findings in a final report. This summative report will address the following questions: Are some of the mapping strategies more effective than others? Does *CmapTools* facilitate development of a learning community? Does the team recommend the extension of *CmapTools* to other subject areas and grade levels?

The report will include a summary of the team's learning; final revisions to the "Cmap Tools Manual for LHS Educators"; maps aligned with LHS curriculum and state frameworks; team teachers' and representative students' maps and evaluations of the experience; average mapping performance over 2 units; correlations of learning style questionnaires with student evaluations of maps and map performance; correlation of concept mapping evaluations with class test results.

Phase 4: The Sharing (April - May, 2007)

The project team is connected to a diverse set of educational colleagues. B. Newkirk and E. Gimble will share results with their respective departments by organizing a 2-hour interdepartmental meeting/training. J. Heinze-Fry will share the results with Dr. Joseph Novak, the IHMC concept mapping development team, future international concept mapping conferences, and her colleagues in Maine who are considering making *CmapTools* available on all the states' public school laptop computers.

Qualifications:

Elliott Gimble has taught in the LHS Science Department since 2000 and has a Masters Degree in Forestry Science from Yale University's School of Forestry and Environmental Studies. He is interested especially in finding effective teaching methods for struggling learners and using technology in the classroom. (In 2005, he completed the EDCO Summer Technology Program course *Best Educational Resources on the Web*.) Prior to coming to LHS, Mr. Gimble worked in the non-profit sector, supervising students and others pursuing environmental and social justice-related community service.

Environmental educator and consultant **Jane Heinze-Fry** earned her doctorate in Science and Environmental Education from Cornell University in 1987 and has extensive teaching experience in science classrooms from the middle school to college levels. In addition to her publications and work with concept mapping (see Heinze-Fry, J., 2004), she is also an LHS parent, past parent co-coordinator of Bowman's Big Backyard, and brings to the project a sound understanding of the challenges facing our students.

Barbara Newkirk has been a special education teacher at Lexington High School since 1994. She earned her M.Ed. in Moderate Special Needs 5-12 from Fitchburg State College. Prior to moving to Massachusetts, she taught elementary and middle school in Maryland with a focus on language arts and science. Finding ways to help students organize, understand, recall and connect ideas is a crucial part of her work.

Citations:
Cañas, A. J., Hill, G., Carff, R., Suri, N., Lott, J., Eskridge, T., Gómez, G., Arroyo, M., & Carvajal, R.. 2004. "*CmapTools*: A Knowledge Modeling and Sharing Environment", In A. J. Cañas, J. D. Novak & F. M. González (Eds.), *Concept Maps: Theory, Methodology, Technology, Proceedings of the 1st InternationalConference on Concept Mapping*. Pamplona, Spain: Universidad Pública de Navarra. 2004.

LHS Science Dept. Mission Statement, 2004. http://lps.lexingtonma.org/curriculum/science.html, Posted March 4, 2004.
LPS Systemwide Goals, 2005. http://lps.lexingtonma.org/aboutlps.html**,** Posted: Sept. 1, 2005; approved by the Lexington School Committee September 20, 2005.

Novak, J. D. (1998). *Learning, Creating, and Using Knowledge: Concept Maps TM as Facilitative Tools in School and Corporations.* Mahwah, N.J.: Lawrence Erlbaum Associates.

Heinze-Fry, Jane, 2004. "Applications of Concept Mapping to Undergraduate General Education Science Courses," *Proceedings of the First International Conference on Concept Mapping,* A. J. Cañas, J. D. Novak, F. M. González, Eds., Pamplona, Spain 2004

Budget*

Phase One: $1100
Work with tech support to download *CmapTools*/ Consult with IHMC
$ 50
Research, provide appropriate materials to Elliott and Barbara
$100
Draft "Cmap Tools Manual for LHS Educators"
$200
2 Meetings (2 days): Intro to Concept Mapping;
$150
      collaboration on mapping evaluation and Fall strategy
      Stipends: E. Gimble and B. Newkirk ($150/each x 2 days)
$600

Phase Two: $1200 total for two units
Develop concept map (1) aligned with frameworks**
      $ 500
Facilitate discussions on which mapping applications to try.(2)
      $ 100
Attend class (2)
      $ 100
Collect/evaluate data (2)
      $ 400
Meetings to share results for each unit/planning of next steps (2)
      $ 100

Phase Three: $1000
Consolidation, Analysis, Drawing Conclusions, Writing Report
      (summative evaluation)
      $1000

TOTAL
      $3300

Additional In-Kind Support includes:

• Computer room (1 computer/ student); laptops (1 computer/ 2 students); time for computer technology assistants to download software. (LHS Tech Support has indicated its support.)

• School will provide professional development time for E. Gimble and B. Newkirk to share their work. School will grant PDPs to B. Newkirk and E. Gimble for their participation in this work.

• J. Heinze-Fry will share the results with her aforementioned colleagues.

- *CmapTools* is free to educators and nonprofits.

* Budget figures (except for non-contracted staff hours) are based on consultant fees for estimated time needed per activity

** Consultant (Heinze-Fry) will develop the first concept map; LHS collaborators will develop the second concept map during contracted staff time.

The funds will go to the consultant for coaching, data collecting, mapping, curriculum alignment, and reporting the results of this collaborative effort to learn about the application of concept mapping in the high school biology classroom and resource room. Stipends for Phase One non-contracted staff time are budgeted for E. Gimble and B. Newkirk. If only partial funding is available, we would put a priority on implementing and evaluating in-class applications while reducing the scope of the broader assessments and training.

Appendix B2

Summer Planning Documents

B2.1 Summary Summer Meeting

B2.2 C3M Reading List: *Initial and Revised*

B2.3 *CmapTools* Questions

B2.4 Creating Concept Maps

B2.5 Draft Rubric to Evaluate Concept Maps

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Appendix B2.1
Summary Summer Meeting

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We met for 3 ½ hours and accomplished much. I hope you feel the extra time is worth it. And I feel that we accomplished enough to get us all on track for what we can do this summer. Though it may have seemed we veered off agenda a number of times, I appreciate that the following was accomplished:

1. We all have a better understanding of how each of us is fitting the C3M Project into our overall professional goals.

• Barbara, we expect you to keep us to the "essential" concepts whenever we wander into the ozone. Elliott agreed to share his objectives with you for his courses. And he shared with you that there is a certain amount of coordination among the teachers at each level, but that each has freedom in teaching strategies and that there is flexibility in emphasis. So for you, that probably means that it might be especially helpful to get a set of objectives from the teachers your students have. We also understand how you might synthesize the *CmapTools* work with the "strands/schema" type work from your other course.

• Elliott will be trying to move his whole class forward toward meaningful learning of key biological principles. That's away from rote learning. And it's making sure that the forest doesn't get lost in the trees. Further, Elliott will be using *CmapTools* with other teaching/ learning strategies. In particular, we are looking for effective ways to help students integrate their inquiry learning and personal experience (prior learning) with their new learning about biology.
Elliott, we had a chance to work with your Evolution Map, which was an awesome start. Thanks for sharing it. It especially gave us a chance to talk about which types of relationships lend themselves easily to concept mapping (general to specific) and which do not (flow charts and historical time lines). These other relationships can be described in digital documents that can be linked to concepts in a concept map. We also clarified the difference between a concept [perceived regularity in an object (such as a cell) or event (such as photosynthesis)] and a particular example of a concept (i.e., Darwin). Examples are OFTEN included on concept maps, but they are found toward the bottom of the map and are used to illustrate a concept.

• Jane sees this project as a perfect opportunity to test out *CmapTools* with students to empower students with constructivist learning. This is a chance to iron out bumps that we run into on a small scale. When we find effective approaches that work, we will be able to extend our findings to the rest of the learning community. I would hope to see us expand the use of *CmapTools* to the other sciences and ultimately K-12. I would like to be able to demonstrate visually how *CmapTools* helps us meet the state frameworks and more. As other countries are moving forward so quickly in the implementation of *CmapTools*, I would like to see at least one whole school system offer *CmapTools* as a teaching/learning strategy to its public school community. I would like to explore how our experience might be of interest to the Massachusetts Department of Education.

2. We discussed the differences between concept webs (which are more free-form, less hierarchical, and don't have propositional linking words) and concept maps (which are hierarchical and require clarification of just how the words are linked. While webbing may be good for creative brainstorming, concept maps are more intellectually demanding.

3. We discussed strategies to engage students and parents from the beginning. Back to school night and parent signatures on the first letter to go home at the beginning of the year were discussed.

4. We started a tentative discussion about directions that will be need to given to students to start their mapping process. "Structure, Function, Illustration" were our first three criteria. We will want to clarify that as the time gets closer. AND we will clarify our criteria on a rubric so there are NO surprises for the students.

5. Nitty gritty. Elliott has Jane's information to implement the Consultant Number procedure to facilitate payment in the fall. Elliott and Barbara have contact information to reach each other.

Barbara needs to:
Create a map.
Decide whether to work with concept mapping with just life science students, earth science students, or both. Barbara, while Elliott's students will be creating small concept maps to fit into larger overarching maps, you will need to decide if that is the best approach for your students. You may find that you want to move in different increments from how Elliott moves for the classroom setting.

Elliott needs to:
Revise his Evolution map.
Decide which classes he will or will not be using concept mapping with and clarify how he wants that decision to interact with the C3M Project.
We need to clarify with Dr. Jones if we need permission to use the students' work. I'm expecting to use it in a research paper. With college students, I use their names to give them credit for their work. Shall we do this with our high school students? Because of their age, do the parents need to sign something? This comes under "Human Subjects" research guidelines.
Elliott needs to decide which chapter we will ask students to concept map for their second try. (Any thoughts on this, Elliott? We might want a breather between chapters. BUT, I think it will be easier if we do it in the first quarter. . .)
Add a paragraph about the C3M project to his beginning of the year handout.

Elliott and Barbara both need to:
Do some background reading.

Relate the C3M Project to their other professional development.
Send Jane any revisions on the Logic Model or Evaluation Matrix.
Send Jane any questions you want her to address at the conference.

Jane needs to:
Provide a revised Line of Logic.
Provide a revised reading list with easier access on the web for some of the resources.
Jane will mail two printed resources to Elliott, who will mail them on to Barbara over the course of the summer.
Print out the overview map and give it to Elliott.
Prepare the Chemistry of Life Overview Concept Map and Detail Maps as a Demonstration for the high school students.
Share a "How to concept map" handout with Elliott and Barbara so they can revise it for their students as they see fit.
Create a rubric to evaluate maps and offer to Elliott and Barbara for editing.

Some of the future needs we will have include:
An easy questionnaire to give students to distinguish "learning styles"
Student evaluations of their experience with mapping
Teacher evaluations (for Barbara and Elliott) to describe their experience with mapping with students.

Looking over the Line of Logic for our Planning Meeting, I think we made a good start in clarifying, simplifying, and prioritizing our objectives. We will have individual students take responsibility for mapping. We will have teams produce maps with students talking over and "negotiating meaning." We have the laptops for students to use *CmapTools* at school. We will share our results with our respective professional communities.

We don't expect students to load *CmapTools* on their computers at home, although some might. We don't expect students to collaborate with *CmapTools*, although we might and some of the students might.

If you wish to create/edit/email concept maps to me over the next two weeks, I'll be glad to give you feedback. And that will put us in line with our timeline expectations.

Thanks to both of you for a great evening. May you get moments of total relaxation to restore your batteries for the Fall.

Jane

PS Attachments:
1. Revised Line of Logic Model
2. Revised reading list with URLs
3. Current question list

Appendix B2.2
Recommended Reading Lists for Teachers
Initial List

Novak, Joseph D. and Alberto Cañas. ***The Theory Underlying Concept Maps and How to Construct Them***. Dowloadable as pdf file at
http://cmap.ihmc.us/Publications/ResearchPapers/TheoryCmaps/TheoryUnderlyingConceptMaps.htm
This 31-page resource provides a bridge between Ausubelian Learning Theory and Concept Mapping.

Novak, Joseph D. ***Learning, Creating, and Using Knowledge. Concept Maps as Facilitative Tools in Schools and Corporations.*** 1998. Mahwah, New Jersey: Lawrence Erlbaum Associations, Publishers. *Chapter 7: The Effective Teacher/ Manager.*

Some teachers in the Lexington Public School System use *Inspiration* software. *CmapTools* is different because it is web-based and can therefore be collaborative in nature. Please reflect about this collaborative aspect regarding the C3M project and how this quality may affect future applications of *CmapTools* within the Lexington System. Also, please choose one paragraph of interest to you and describe how it may contribute to your own professional development and/or that of the students with whom you work.

Heinze-Fry, J. A., & Novak, J. D. (1990). ***Concept mapping brings long-term movement toward meaningful learning***. Science Education, 74(4), 461-472.
Hand out describing how concept mapping affects long term retention by college biology students. Thus contributing to meaningful rather than rote learning (memorization) which is quickly forgotten.

Heinze-Fry, J. A. (2004). ***Applications of Concept Mapping to Undergraduate General Education Science Courses.*** In A. J. Cañas, J. D. Novak & F. M. Gonzalez (Eds.), *Concept Maps: Theory, Methodology, Technology, Proceedings of the 1st International Conference on Concept Mapping*. Pamplona, Spain: Universidad Publica de Navarra.

This article describes a variety of applications of *CmapTools* in College Introductory science courses. The idea is to look at how both teachers and students might apply concept mapping in different ways. You should reflect on what you'd like to try in the C3M Project. Available at
http://cmc.ihmc.us/CMC2004Programa.html On the Conference Program, scroll down to B8.

Heinze-Fry and Fran Ludwig. 2006. ***CMAPTOOLS Facilitates Alignment of Local Curriculum with State Standards: A Case Study.*** To be published in the 2nd International Conference on Concept Mapping. San Juan, Costa Rica: Universidad Costa Rica.
Describes how concept mapping was used to align with State Science Standards. You should reflect on how this strategy might be useful at LHS with science testing becoming high stakes. Get down to the "essential concepts." How might this approach be applied across K-12 and all the sciences (especially life science and earth science) in the Lexington Public Schools? (I'll attach this article in an email.)

Introduction to CmapTools of LHS Teachers. 2006. This is a Draft document to help teachers use *CmapTools* to create concept maps. We worked with this a bit last year.   I'll attach the current version. The parts on creating your own map have been updated and I'd appreciate your review. The parts on collaboration with *CmapTools* should be updated and edited to be used with each of your professional development sessions for the Spring. (One thought. You might

consider maximizing your professional development effectiveness by presenting the C3M results and then using the computer bank to have teachers use *CmapTools* themselves!)

Shaka, Farella L. and Betty L. Bitner, Southwest Missouri State University. " Construction and Validation of a Rubric for Scoring Concept Maps." 18p. http://www.ed.psu.edu/CI/journals/96pap43.htm

 A large reference list to select from is available at: http://cmap.ihmc.us/Publications/ReferenceList.php
IMPORTANT: You can get to all of the papers presented at the First International Conference in Concept Mapping at this site.

Revised List

Getting Started: Beginning Theory and Practice

The Theory Underlying Concept Maps and How to Construct Them
http://cmap.ihmc.us/publications/researchpapers/theorycmaps/theoryunderlyingconceptmaps.htm

Concept Map of Concept Maps
http://cmapskm.ihmc.us/servlet/SBReadResourceServlet?rid=1064009710027_1483270340_27090&partName=htmltext

CmapTools Around the World
http://cmapgis.ihmc.us/

Download *CmapTools*
http://cmap.ihmc.us/download/

Tutorial from the University of Wisconsin on Using *CmapTools*
https://pantherfile.uwm.edu/xythoswfs/webui/simonec/public/Learning%20Objects/*CmapTools*?action=frameset&subaction=print&uniq=-28ctbb
Open (double click) the CmaptTools Basics folder. Click on Cmap Tools Basics.htm Make sure your sound is "ON" Enjoy the tutorial.

Advanced Work in Concept Mapping

Proceedings of the Second International Conference in Concept Mapping
http://cmc.ihmc.us/CMC2006Program.html

Program and Proceedings of the First International Conference in Concept Mapping http://cmc.ihmc.us/CMC2004Programa.html

Research Publications regarding IHMC Projects on Concept Mapping
http://cmap.ihmc.us/Publications/

CmapTools White Papers (Technical Support)
http://cmap.ihmc.us/Documentation/WhitePapers.php

Shaka, Farella L. and Betty L. Bitner, Southwest Missouri State University.

" Construction and Validation of a Rubric for Scoring Concept Maps." 18p.
http://www.ed.psu.edu/CI/journals/96pap43.htm

Books

Novak, Joseph D. *Learning, Creating, and Using Knowledge. Concept Maps as Facilitative Tools in Schools and Corporations.* 1998. Mahwah, New Jersey: Lawrence Erlbaum Associations, Publishers. (Especially *Chapter 7: The Effective Teacher/ Manager.)*

Mintzes, Joel J., James H. Wandersee, & Joseph D. Novak, editors. *Teaching Science for Understanding: A Human Constructivist View.* 1998. San Diego, California: Academic Press.

Novak, Joseph D. and D. Bob Gowin. *Learning How to Learn.* 1984. New York, New York: Cambridge University Press.

Concept Mapping Resources by Members of the Lexington Educational Community

C3M Project. A concept map of the entire C3M Project with attached resources hosted on the Institute of Human and Machine Cognition (IHMC) server.
http://cmapspublic2.ihmc.us:80/servlet/SBReadResourceServlet?rid=115 9656139043_1468204745_4727&partName=htmltext

Cell Structure. Biology Teacher Elliott Gimble's three Level 1 Biology Class Concept Maps on the Lexington website.
http://www.davidcolarusso.com/cgi/staff.cgi?name=Gimble

Heinze-Fry, J. A., & Novak, J. D. (1990). *Concept mapping brings long-term movement toward meaningful learning*. Science Education, 74(4), 461-472.
Hand out describing how concept mapping affects long term retention by college biology students. Thus contributing to meaningful rather than rote learning (memorization) which is quickly forgotten.

Heinze-Fry, J. A. (2004). *Applications of Concept Mapping to Undergraduate General Education Science Courses.* In A. J. Cañas, J. D. Novak & F. M. Gonzalez (Eds.), *Concept Maps: Theory, Methodology, Technology, Proceedings of the 1st International Conference on Concept Mapping.* Pamplona, Spain: Universidad Publica de Navarra. This article describes a variety of applications of *CmapTools* in College Introductory science courses. The idea is to look at how both teachers and students might apply concept mapping in different ways. Available at http://cmc.ihmc.us/CMC2004Programa.html On the Conference Program, scroll down to B8.

Heinze-Fry and Fran Ludwig. 2006. *CMAPTOOLS Facilitates Alignment of Local Curriculum with State Standards: A Case Study.* To be published in the 2nd International Conference on Concept Mapping. San Juan, Costa Rica: Universidad Costa Rica. Describes how concept mapping was used to align with State Science Standards.

Appendix B2.3
CmapTools Questions

Technical Questions
Can Elliott and Barbara call someone from IHMC to get direct technical support? Can he call Rodrigo Carvajal with any queries?

How does the "Parking Lot" concept work?

Management Questions
How should files be created to control individual, team, and research staff access to the folders and such that student-created maps can be added simply to overview teacher maps?

Will student work be stored on the school server or IHMC server?

Is there guidance on how to introduce a class of Level 1 and/or special needs kids to the concept mapping process and/or *CmapTools*? What problems can we expect to run into? What strategies have the most success? Our current model for our pilot study is to introduce students to the course with an overview map; model one chapter of overview and attached submaps; one chapter of giving students concepts to create submaps that are hooked to a chapter overview map; and, if the students are successful with that approach, then having a following chapter where students identify concepts, create submaps and hook them to an overview map.

Research Questions

Are there any publications about the use of *CmapTools* with Special Needs populations? Are there any guidelines about mapping essential learnings?

On *CmapTools*, how does the websearch function differ from Google? That is, how does it assure that the websites that are brought up are appropriate and meaningful educational resources? (For instance, the Middle School textbooks has filtered resources that the students using the textbook can access as resources. Further, these resources are labeled with icons to indicate type of resource: movie, inquiry, data file, interactive, etc.

Are there any good rubrics for evaluating concept maps out there?

Is there a simple learning style questionnaire that we might administer to our students and run correlations with their evaluations of the concept mapping experience?

Joe: In light of vee-mapping. . . HOW do you see that inquiry experiences can be linked to student-generated concept maps?

Appendix B2.4

CREATING CONCEPT MAPS
Jane Heinze-Fry, Ph.D.

Significance of Concept Maps
The creation of concept maps clarifies your growing conceptual framework as you learn a new field of study. This conceptual framework is very significant because it forms one of the filters through which you view and interpret your world and the basis for your problem-solving processes.

Characteristics of Concept Maps
• On a concept map, each individual *concept* is circled. Each concept is connected to other concepts by lines. On each line is a *word that describes the relationship* between the two concepts.
• Concepts are arranged in a *hierarchical* scheme. The most general concepts are at the top. As you progress to the bottom of a concept map, the concepts get more and more specific.
• Concepts in different parts of the map can be integrated by **crosslinks.** One of the strengths of concept maps is that they can show much more than linear outlines how concepts are connected to each other.

How to Make a Concept Map
1. List the concepts. When you are studying primarily from a textbook, the easy way to do this is to list words that are in bold or italics. They are generally the most important concepts in the chapter.
2. Cluster concepts into closely related groups. (It is often easiest to use chapter subheadings to do this clustering.)
3. Arrange clusters from general to specific.
4. Draw in connection lines with relationship labels.
5. Add or delete concepts to "make the map work for you." Some students need to add concepts that they bring from prior experience. Some students need to delete concepts to improve clarity and cut the confusion created by too many concepts.
6. Crosslinkages within the map or to other prior-constructed maps can be drawn in.

Qualities of Good Concept Maps
1. Concept maps are personal and reflect your own way of thinking. If you work from someone else's map, you should adapt it to your style.
2. Relationship words are appropriate and are carefully indicated on each line.
3. The map is clear and easy to follow.
4. The map is innovative, offering new insightful connections, creative use of color, powerful crosslinkages among chapters, strong integration of knowledge including notes to other ways of representing knowledge such as text diagrams, charts, graphs, etc.

Appendix B2.5
Heinze-Fry Draft Rubric to Evaluate Concept Maps

Quality	4	3	2	1	0
Concepts	More than required concepts are circled on map	All of required concepts are circled on map	Most of required concepts are circled on map	Some of required concepts are circled on map	Required concepts are not circled on map
Concept Relationships (Propositional Linkages)	All linking words are present and valid.	Most linking words are present and valid.	Some of linking words are valid.	Few linking words and not all are valid	Missing or incorrect linking words
Hierarchy	Five or six levels of hierarchy are present and valid	At least four levels of hierarchy are present and most are valid.	Clear linkage to overview and at least three levels of hierarchy are seen.	Clear linkage to more general concept in class overview map	No hierarchy demonstrated
Crosslinks	Makes more than two crosslinks within or between team maps	Makes a valid crosslink within the team map and to another team's map	Makes a valid link between two branches of the map	Connects one branch of the map with another branch	No crosslinks between different branches of the concept map
Context Links Real world situation/problem Personal relevance; Laboratory experiment/ demonstration; Prior school learning; Educational websites	Creates links to all five contexts	Three or four out of five possible contexts	Two out of five possible contexts	At least one out of five possible contexts	No links to prior learning or experience
Visual presentation Clarity and Creativity	Map demonstrates creative and meaningful use of optional tools of box shape, line, and color	Map demonstrates clear use of basic tools of box shape, line, and color	Map consistently demonstrates clear hierarchy levels and no visual spaghetti	Map mostly demonstrates nonoverlap of lines and even levels of hierarchy	Map has poor appearance (visual spaghetti) or messy or unappealing and uses the basic tools of shape, line and color

Appendix B3

Workshop

CmapTools for Teachers

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2007

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Recommended Concept Mapping Resources

Download *CmapTools*

Downloading *CmapTools* is a straightforward process.
Simply go to: http://cmap.ihmc.us/
Point to Download.
Choose your platform.
Follow the directions.

Getting Started with *CmapTools:* Digitizing your Concept Maps

There are a variety of strategies to "get over the learning curve" of making your own concept map using *CmapTools.* It's different strokes for different folks. Here are some possibilities:

1. Explore! Simply go to the pull-down menus listed across the top of the window and pull down all the options. That exercise alone will give you a good idea of the capabilities and limits of the software.
2. Take a guided tour. A tutorial was created by staff at the University of Wisconsin, Madison, and is available via the web at: https://pantherfile.uwm.edu/xythoswfs/webui/simonec/public/Learning%20Objects/*CmapTools*?action=frameset&subaction=print&uniq=-28ctbb
   Open (double click) the CmaptTools Basics folder. Click on Cmap Tools Basics.htm Make sure your sound is "ON" Enjoy the tutorial.
3. Trial and Error. Double click to add your first concept. Then go to the Help Menu and scroll for the section that addresses the function you wish to perform.
4. Direct instruction. If you want to be guided through the basic steps to transform your concept map into digital form with the *CmapTools* software, follow the steps below to create, add resources to, embellish, and polish your map. (Help Menu in a more developmentally sequenced approach)

Using *CmapTools:* An Overview

The Views window is the organizational hub. Here you decide what stays on your onw hard drive and what is stored on remote servers with access to the larger learning community you designate.

Default choice is "Cmaps in My Computer." At this location, you will create your own Cmaps.

Shared Cmaps in Places is where you can make your cmaps accessible to others via the remote server.

History will record the maps you've visited and edited.

Favorites will let you mark your favorite cmaps.

Create a Cmap

To create a new cmap, select File from the Menu bar, then drag down to New cmap. Alternatively, use the keyboard: Ctrl+n

Add a Concept. Double click anywhere on the window. A selected (highlighted) box with "????" will appear. Type in your concept. Click outside the box to set the concept label.

Create a Proposition from one Concept. Select the concept you want to connect by clicking on it. Point and click on the arrows that appear at the top of the concept box. Drag a short distance from the concept, and a line will appear where you dragged. A concept phrase will appear. Select and type in the linking word. Select and type in the connected new concept.

Create a Proposition from Existing Concepts. If you have two concepts that you wish to connect, select one concept. Point and click the arrow box above the concept, and drag to the concept you wish to connect. When this second concept highlights, release the mouse. A line will connect the two concepts, and a proposition box will be highlighted. Type in the linking word. Click outside the box to set the propositional phrase.

Save your Concept Map. Select File, then either Save Cmap if you intend to save editing on an existing Cmap, or Save Cmap As to save a new Cmap. The "Save Cmap As" window will appear. Here, you can label your Cmap, give it a focus question, and assign keywords to it. The Author, Organization, and Email text fields are where you can add additional identifying information. At the top of the window, there is a computer button that lists the contents of the My Cmaps folder, and a globe button that lists the servers that are a part of Places. The computer and globe buttons give you the option of saving your Cmap locally, or saving it on a Cmap server that you have permission to use. The Cmap you saved will appear under the My Cmaps heading.

Search/Add Concepts and Resources

Drag in Resources. The easiest way to add resources is by dragging them from the desktop or an open folder to the open Cmap. Point to the icon, click down to highlight, and drag the arrow over the concept to which you wish to link the resource. And "Edit Resource Link" window will appear. If the resource is to be simply background, select that radio button. Otherwise, "Add as a Resource Link" is the appropriate button. The Label you type in will appear when others who are viewing your cmap choose to investigate the resources. Select a group from the next box down. An icon will identify the group to which the resource belongs. Each concept may have up to 13 icons attached, each representing a different type of resource. The "Resource Name" shows in the "views" window. The Resource Type identifies the type of data in the resource. Fill out Description and Keyword boxes. Click OK at the bottom of the window when you are finished. The icon of the added resource should appear on the concept of your Cmap.

Import Resources. You can import a resource from a file or create an internet shortcut. To import a resource from a file, From the Views-Cmap Tools Window, select File, then Add Resources. Using the "Add Resources" window, you can manually navigate through folders to add resources for use in Cmaps. Once you have located a resource you would like to add to a Cmap in the future, highlight it and click the Add button. An "Edit Resources" Window will appear. Fill out the boxes, and click OK at the bottom when you are finished. The resource will appear in the Views-Cmap Tools Window and can be dragged onto a concept in a Cmap

at a future date. To create an internet shortcut, From the Views-Cmap Tools Window, select File, then Add Web Page. Fill out the Web Page window, click OK, and an icon will appear in the file where you saved it. As with other resources, it, too can be dragged to an open Cmap.

Add & Edit Links to Resources. In an open Cmap, highlight the concept of interest. Click on Edit, then the "Add & Edit Links to Resources." You can "add" as described above or you can edit an individual resource by highlighting it in the lower box, and clicking the edit button at the bottom. The original resource description box will open; you may edit, click update, and the revisions are saved.

Manage Existing Resource Links. A group of resource links can be transferred between concepts in an open Cmap. Highlight a chosen icon of a group. Edit cut. Highlight an alternative concept. Edit Paste. Or use the cut paste commands to which you are accustomed.

Search Places. You can search my Cmaps and Places. From an opened Cmap, Point to Tools in the menu bar, then Search, then Cmaps and Resources. Type in the concept you wish to search. Double click any results of the search you wish to explore.

Search the Internet. From an opened Cmap, Point to Tools in the menu bar, then select Search then Web Information. As above, double click to view, or drag and drop as a resource onto you cMap.

Embellish a Cmap

Modify Linking Lines. In an open Cmap, select a line. Modify the line by using the Style Palette. If your style palette is not open, point at Window in the Menu Bar, and scroll down to "Show Style Palette." By clicking in different sections of the Style Palette, modify the line: color, thickness, style, shape (curvature/ vectors), connection direction, and arrowheads.

Change Colors. Colors of the text, object fill, object outline, shadow, arrows, can all be changed using the Style Palette. In addition to the given Palette, you can add More colors to the Palette.

Change Font and Size. Choose Font on the Style Palette to change the Font and Size of the font; select bold or italics; select text color, and

adjust text alignment left justified, centered, right adjusted, shifted toward the top or shifted toward the bottom in relation to the box.

Polish a Cmap

Find Text in a Cmap. From and opened Cmap, point to Edit in the menu bar, then find. Type your word, and it will highlight.

Spell Check. With an opened Cmap, select to Tools then Spelling. This will correct common errors. Spelling Options allows you to add words to the Dictionary.

Dictionary and Thesaurus. As spellcheck, with an opened Cmap, select Tools, then dictionary and thesaurus. Type in the word of interest, and get options.

Organize Cmaps
Create a Learning Community: Sharing with Others

To Print a Cmap. First, go to Page Preview via "File" on the Menu bar. Choose orientation (Portrait or Landscape). Choose how many pages you want the map to be printed on. Hit OK to Print Later. Or Print to Print now.

Export Cmap as an Image. From open Cmap, point to File in the menu bar, then "Export Cmap as" then Image. In the Window that pops up, select the Title (default is the Cmap name), percent size, and File Type. Click Save to set the action.

Create a Learning Community: Copy a Cmap to Places (a public server).

From the "Views - *CmapTools*" window:
You can copy a Cmap to a place in the *CmapTools* network, making it possible to share Cmaps with others. Even if the Cmap you want to share does not contain any links to outside resources, someone who has been given access to the shared Cmap may eventually want to add resource links to it. To ensure that all resource links in a Cmap remain valid after copying the Cmap to Places, begin by clicking an unused space in "Views" under the My Cmaps heading, then click Folder... from the New sub-menu.

The "New Folder" window appears where you can give the folder a name, add searchable keywords, and add a folder description. The section Permissions & Access Control explains how the Permissions... button can be used to secure folder content. A knowledge model is a folder containing several Cmaps of information that provide detail to a domain of knowledge. Faculty and curriculum coordinators may be especially interested in this feature. A common way of unifying a knowledge model is through the use of a top level Cmap. The Set as Knowledge Model box can be checked to change a folder's icon to the knowledge model icon, indicating that the folder most likely contains a top level cmap that links to other Cmaps also contained in the folder. To finish creating the new folder, click OK.

After you have created a folder, select a Cmap and its associated files. To place the selected files into the newly created folder, click the highlighted selection, then click either Cut or Copy.

Click the new folder, then place the Cmap and its associated files into the folder by clicking Paste.

Click the Shared Cmaps in Places button to view a list of places in the *CmapTools* network. If you are unsure of where you should place your Cmap folder, places with "public" in the title typically permit any *CmapTools* user the ability to copy, or publish, Cmap folders to that place. [I use IHMC Public Cmaps (2).]

Now when opening the place where you pasted your Cmap folder, it appears in the list for anyone who accesses that place.

Appendix B4

Fall Planning Documents

B4.1 *CmapTools* Questions and Answers

B4.2 Summary Fall Meeting

B4.3 Summary Fall Phone Communication

Appendix B4.1
CmapTools Questions and Answers

Technical Questions
Can Elliott and Barbara call someone from IHMC to get direct technical support? Can he call Rodrigo Carvajal with any queries?

How does the "Parking Lot" concept work? I've heard this described. It's when a class is collaboratively working on a concept together, sometimes for the teacher to determine the level at which to begin teaching the concept. The teacher mentions the key concept (such as photosynthesis). The class brainstorms all the concepts they can think of that they associate with the concept (such as green plants, carbon dioxide, oxygen, etc.) These brainstormed concepts (about 15-25) make up the 'parking lot.' The teacher asks the class to cluster them together and construct a preliminary map. (See cmap.ihmc.us/Publications/ResearchPapers/ TheoryCmaps/TheoryUnderlying**Concept**Maps.htm)

Management Questions
How should files be created to control individual, team, and research staff access to the folders and such that student-created maps can be added simply to overview teacher maps? Will student work be stored on the school server or IHMC server?

Thomas Eskridge, who is a technical software author and ran the Advanced Concept Mapping Workshop, suggested that we use the IHMC server to store all the C3M Project work and make use of the Permissions system. Within the "White Papers" section of the IHMC website, there is a paper discussing strategies for such permissions. See "Permissions and Access Controls" at cmap.ihmc.us/Publications/ResearchPapers/ TheoryCmaps/TheoryUnderlying**Concept**Maps.htm

Is there guidance on how to introduce a class of Level 1 and/or special needs kids to the concept mapping process and/or *CmapTools*? What problems can we expect to run into? What strategies have the most success? Our current model for our pilot study is to introduce students to the course with an overview map; model one chapter of overview and attached submaps; one chapter of giving students concepts to create submaps that are hooked to a chapter overview map; and, if the students are successful with that approach, then having a following chapter where students identify concepts, create submaps and hook them to an overview map.

Joe Novak has directions on how to map hooked to the top concept of his "Concept Map of Concept Maps."
(http://cmapskm.ihmc.us/servlet/SBReadResourceServlet?rid=1064009710027_1483270340_270 90&partName=htmltext) I've also written directions and they are attached to the C3M Concept Map as a Resource entitled "Concept Map Directions."

University of Wisconsin has developed a *CmapTools* tutorial, which does a reasonable job on the mechanics of creating concept maps in a digital way. It would probably be a good idea for each of us to try it. I'm not sure it's appropriate for all students, but it might be appropriate for those who are technically inclined. Then they could facilitate their groups better.
cmap.ihmc.us/Publications/ResearchPapers/ TheoryCmaps/TheoryUnderlying**Concept**Maps.htm

Research Questions
Are there any publications about the use of *CmapTools* with Special Needs populations?
Are there any guidelines about mapping essential learnings?

A Google search brought up some good possibilities to try. I've linked the following to the Conference concept on the C3M concept map:
Supporting Students with Learning Disabilities in High School Science
http://cse.edc.org/products/supportingstudentsld/key_researchers.asp
CAST: Graphic Organizers with UD> (Advance Organizer) Journal of Research in Science
Teaching: www.**cast**.org/publications/ncac/ncac_goudl.html

On *CmapTools*, how does the websearch function differ from Google? That is, how does it assure that the websites that are brought up are appropriate and meaningful educational resources? (For instance, the Middle School textbooks has filtered resources that the students using the textbook can access as resources. Further, these resources are labeled with icons to indicate type of resource: movie, inquiry, data file, interactive, etc.
The websearch on *CmapTools* is contextualized; that is, it doesn't bring up ALL the stuff that Google does. It brings up sites that are related to concepts that are on the map being created.

Are there any good rubrics for evaluating concept maps out there?

Some rubrics look at topology of concept maps (structure), while others look at quality of connections (semantics). There is a sample rubric that we can discuss attached to the C3M concept map. "Rubric to Evaluate Concept Maps."

Is there a simple learning style questionnaire that we might administer to our students and run correlations with their evaluations of the concept mapping experience?

I didn't hear much about learning styles this year. One paper by Richard Iuli, et al. is worth looking at. They used a simple questionnaire that distinguishes surface from deep learners. Unless someone at Lexington High School has better advise, I'd go with this questionnaire. (The research on learning styles turns out to be very messy and controversial. Big reliability/ validity issues, it appears.)

Joe: In light of vee-mapping. . . HOW do you see that inquiry experiences can be linked to student-generated concept maps?

There was a LOT of discussion about how the questions we ask DRIVE the nature of the concept map that is produced. Elliott, we talked about this a bit when we brainstormed that we wanted students (on maps of cell organelles) to include structure, function, and a visual. I spent an afternoon discussing this issue with Richard Iuli, Empire University, New York State. In order to ensure meaningful learning that maximizes connections that students make, we propose the following questions: What do we know about the organelle (structure, function)?
1. How do we know about the organelle (scientific methods: experiments, observations)
2. How can we visually represent the organelle (google search: photos, drawings, videoclips, graphics)
3. Who cares about this knowledge (personal, social meaning: problem-solving; increased understanding; empathy)
4. Can you connect this biological knowledge to another discipline (chemistry, physics, literature, art)
(Also, refer to my Notes on the Conference, which is attached to the C3M Concept Map.)

Appendix B4.2
Summary Fall Meeting
October 2, 2006

Barbara Newkirk
• Barbara has the original special needs concept map uploaded in her BN. . . .folder on IHMC Public Cmaps 2. She is currently working on her IBM ThinkPad in My Cmaps and does not have compatibility with her computer at home.
• Barbara's original Planets cmap was emailed in jpeg format. Jane saved it on the desk top and attached it to our C3M Public Map on the IHMC Public Cmaps 2 site.
• Barbara has enjoyed some "connective" opportunities with her students reviewing the Renaissance and its roots.
• "Teachers really get that this as a way for kids to show their understanding and think in systems to see the big picture."
• Barbara will:
- Edit the Chapter 27 map to move descriptors under the inner planets; then crosslink the inner and outer planets.
- Create a comparison table of planets with their characteristics on word and save it to her Cmap folder on My Cmaps.
- Add the table to the top concept as an attached Resource.
- Contact the tech person about the permissions problem and lack of ability to consistently upload cmaps to IHMCPublic Server 2.

Elliott Gimble
• Elliott has a tentative schedule for the content he'll be teaching this Fall. He is working with two other teachers about the schedule. Current plans are:
10/23   Finish Plants: Test (Structure/Function) Groups of Plants
10/30   Finish Organic Molecules: Test (Link to Digestion) (C3)
11/6   Brain and neuron case study mini unit on web and elsewhere around addiction neurotransmitters
11/13   Cells and organelles: prokaryotes/ eukaryotes, plants and animals
11/20   pH/ enzyme (C5)
• Elliott and Jane met our LEF shepherd Sue Schiffer at the Thurs. LEF grantees event.
• Elliott will send Jane maps of macromolecules and objectives for cells and organelles.

Jane Heinze-Fry
• Northbridge is developing quickly in extending *CmapTools* to faculty and students. We'll keep posted through communications with Jim Gorman, chemistry teacher, who is spearheading their work.
• Jane has talked with Lynn Sarasin, Deputy Superintendent of Curriculum and Professional Development and sent letters to Clarke Middle School Principal Flynn and Harrington Elementary School Principal Crump regarding use of *CmapTools* to demonstrate growth of conceptual frameworks across the levels.
Jane will:
- Summarize the meeting.
- Create a demonstration map for macromolecules, including the detail maps from Elliott on particular macromolecules.
        - Create an overview map of Cells. Kids will work on particular organelles.

Appendix B4.3
Summary Fall Phone Communication
October 29, 2006

Elliott and Jane spoke for 30 minutes on the phone.

The BIG realization was that we are not as limited by technology as we thought. Since our work can be saved as webpages (listed at the bottom of each map we load onto the public server), students will be able to view cmaps that we create on *CmapTools* at home. Originally we had thought, students would need to have *CmapTools* loaded onto their computers in order to view cmaps, but that isn't so. They will also be able to open any digital resources we link to the maps.

Elliott gave Jane feedback on the umbrella map of macromolecules as well as the detail Carbohydrate and Lipids maps. This discussion clarified structure/function and we had some discussion about what was essential. Also, we wanted to demonstrate significance as an important part of the map, but this information tends to be personal and "nonessential," although it provides motivation and attaches meaning to the concepts, which is very important.

Next steps for this week. By Tuesday, Elliott will email to Jane his outlines of macromolecules. Jane will link these to the umbrella concept map. Elliott gets major kudos if he is also able to email Jane "essential" visuals from the textbook CD AND appropriate URLs that he would like to have linked to the website. (In particular, the Concord Macromolecule website.)

Elliott will use this demo map in class to demonstrate to students how mapping works and how it is different from outlines.

After students have had a chance to look at the cmaps and outlines at home, Elliott will solicit feedback from students via notecards. For example: Are the maps clear and useful? Did you try to access them at home? Were you successful in opening up different attachments? What would make the maps better for you?

Future steps. I'm thinking we might try color coding. Perhaps one color for structure; another for function; another for experiments that support the concepts; another for significance. We might use shades of light and dark to indicate essential or nonessential concepts!

Appendix B5. Student Concept Mapping Experience 1
C³M Team Documents

B5.1 Lesson Plan: Cell Organelles

B5.2 Student Handout: Organelle Mapping Project

B5.3 Directions: Creating Cell Organelle Concept Map Using
CmapTools Software

B5.4 Reflection: Blue Double Blocks

B5.5 Reflections: Green and Red Double Blocks

Appendix B5.1
Lesson Plan: Cell Organelles
December 5, 2006

Objectives:

Knowledge: Name specific membrane-bound cell organelles, their structures,

functions and significant roles they play in cells.

Skills: Explore concept mapping and *CmapTools* software as a means to

understand cell structures and their interrelationships

Materials: Jane's laptop with *CmapTools* (or one of ours with just an internet link) and three cmaps: template, cell membrane and cell structure. Hook up to infocus projector.

Handouts – picture of cell and organelles, paper copies of the three concept maps (mentioned above), assignment with websites for the concept maps (outside of *CmapTools*) and copy of Campbell book figure classifying organelles by functions.

Activities

0-25 minutes Quiz on Cell Membranes
25-30 minutes –Introduce Jane and assignment
30-40 minutes – Show Cell Membrane map and what it can do, segue into Template
40-50 minutes – Show Cell Structure Map and explain that their maps will fit into this one, like the cell membrane map does.
50-55 questions

Appendix B5.2
Student Handout: Organelle Mapping Project

We now are familiar with the cell membrane but what other cell structures can we find inside? This week and next we will be exploring more cell structures, specifically the **organelles**, membrane-bound structures that serve many functions in the cell "factory."

We will also be learning how to design concept maps using software called *CmapTools*. After a refresher on the cell and an introduction to the organelles and to concept mapping, you will work with an assigned partner to write a small concept map using a framework I will provide.   While you all will be responsible for knowing about all the organelles, each team of two will focus on one of the twelve organelles, specifically its structure, function and overall significance. During class this week, you will also find visual resources to illustrate your organelle. Finally, you and your partner will use the software to create a mini-concept map about your organelle then briefly present it to the class next week.

Here are the organelles:

Lysosomes (in animals)

Flagella/Cilia (in animals)

Nucleus (including nucleolus and nuclear envelope)

Endoplasmic Reticulum (Rough)

Endoplasmic Reticulum (Smooth)

Golgi Complex/Vesicles

Cytoskeleton

Mitochondrion

Vacuole

Central Vacuole (in plants)

Chloroplast (in plants)

Cell Wall (in plants)

Web sites with an example of a concept map on cell membrane, a template for your organelle concept map, and an overall cell structures map of all the organelles (which your concept map will fit into) may be found at:

Cell Membrane –
http://cmapspublic2.ihmc.us:80/servlet/SBReadResourceServlet?rid=1165154970624_192798767_6077&partName=htmltext

Template -
http://cmapspublic2.ihmc.us:80/servlet/SBReadResourceServlet?rid=1165154970624_757840968_6075&partName=htmltext

Cell Structures -
http://cmapspublic2.ihmc.us:80/servlet/SBReadResourceServlet?rid=1165154970624_1016149768_6074&partName=htmltext

Appendix B5.3
Creating Cell Organelle Concept Map Using *CmapTools* Software

Goals: *Learn basic CmapTools skills; create cell organelle concept map using*
CmapTools; link your map to the class map.

Part One: Introduction to basic *CmapTools* features and creating your first map.

Under Applications on your laptop, find IHMC *CmapTools*. Click open the application.
It will ask if you want to update the software. **Do NOT do an update. Hit the red circle
in the top left corner to close the update window.** Be patient while *CmapTools* opens.
NOTE that *CmapTools* opens automatically in a "Views – *CmapTools*" window at the
"Cmaps in My Computer" mode indicated by the selected box in the top left corner of the
window.

1. Create your concept map. From the Menu bar, choose "File" and under it, select
    "New Cmap."
2. When a blank, untitled Cmap opens, click in the center to create a concept oval.
    Type a concept word in the oval. You can click on and drag this concept to the
    top of the page.
3. To create a linkage between two concepts (a propositional linkage), point and
    click the small box with arrows at the top of the concept oval. Drag the arrow to
    where you want the new concept. Label the new concept in the oval. Label the
    linking word in the box connecting the two concepts. Continue this with all your
    concepts.
4. Draw and label a crosslink. Point to the arrow box at the top of a concept on one
    side of the map and drag it to a concept it can connect with. Label the linking
    word.
5. Attach a resource. Minimum of 1 resource. Maximum of 4 resources. If your
    digital resource is a file (such as a jpg or Word document), drag and drop your
    resource into the My Cmaps folder. Do the same with a web address. Under
    "Edit" on the Menu bar, go to "Add and Edit Links to Resources". Drag the
    concept that you want to link into the area for adding resources. Click on the
    resource you want to work with and fill in the Resource Window. You can
    choose the type of resource under "Group" (e.g., websites are HTML
    Composites). You will need to put in a title. Click OK when you are done
6. Now drag the Resource from your "My Cmaps" folder over the concept oval
    where you want the resource to be linked. A small resource icon should appear at
    the bottom of your concept word.
7. Having difficulties? Call for help. NOTE the Cmap "Help" Function in the
    Menu Bar. There is a full selection of options to choose from.
8. Note: There are two locations of importance indicated in the "Views -
    CmapTools" Window: "My Cmaps, or "Cmaps in My Computer" which stores
    concept maps on your computer's hard drive" and "Shared Places" or "Shared
    Cmaps in Places", which allows you to collaborate on concept maps via the web.

Part Two: Attach your work to the class map.

Go back to the "Views - Cmap Tools" Window and select "Shared Cmaps in Places." Go to "IHMC Public2". Double click to open the folder (or click the triangle to the left of the folder title). You will now need to open four folders in sequence. In each case, double click on the folder to open it. A new window will open each time you open the folder. Here are the directions for doing so:

1. Scroll down about halfway through the alphabetical listing and OPEN the LHS Gimble
      HFry Folder.
2. Open the Cell Structure Red Folder.
3. Open the Resources for Cell Structure Red Folder.
4. Open the Cell Structures Folder.

Ask for assistance to connect your work to the class resources. You will need to:
1. Create a folder for your concept map and associated resources in the My Cmaps view in the "View Cmap Tools" window. To do this go to file and select New Folder. Label the folder with the name of your organelle and your class section color (red, blue or green). Drag your Cmap and all resources from your "My Cmaps" folder into the folder you just created.
2. From the "My Maps" window, drag your whole folder and drop it into the "Cell Structures" folder that should still be open on your desktop.
3. Time permitting, open your folder and drag your organelle concept map over the corresponding organelle concept oval in the Cell Structure concept map that goes with your class. Fill out the added resource window that appears with the title of the resource your choose. Identify the source of your resource.
4. Check your work. Do this by opening the Cell Structure concept map for your section. Click the icon that opens up your organelle's concept map. Click the resource icons on your concept map to affirm that all resource links are functioning.

Appendix B5.4
Reflection: Blue Double Blocks

Debrief on Cell Structure *CmapTools* Blue Doubleblock (12/8/06)

Overall, I think the doubleblock was very successful.

1. KEY was the obvious observation that the students dove right in with no hesitation. I think we can credit some of that to advanced groundwork laid with familiarity with the concept mapping process and the assignment for students to create individual maps as homework, and the class time dedicated to creating a "shared map" and researching resources on the web. Therefore, students were prepared to use the doubleblock to focus on the use of *CmapTools* to create clear maps that they could then share with the class and that would be linked to a synthesized class map.

2. All student teams successfully created Cmaps, attached resources, created folders on "My Concept Maps" containing both their maps and resources and transferred this folder to shared resources on the IHMC Public Server/ LHS GimbleHFry Folder.

3. It took about an hour to then use the synchronous collaboration function of *CmapTools* between the Heinze-Fry computer and a student computer to link the student maps to the overarching class map. The collaboration function seemed to be required, even though the folder had open "Permissions" for "Everyone" to add to the folder.

4. Some students created their maps, then leaped right into the Pallette to explore color, line curvature, etc.

There were minor glitches, some of which can be ironed out, and some that need some kind of "class policy."

1. One computer was not loaded with *CmapTools*. That one has been marked, and a message given to Tech Support.

2. One team opened up *CmapTools* and successfully created a brilliant concept map but was unable to save their resource. We gave them a different computer, and they re-created their map.

3. A map of mitochondrion was not created due to absence. Elliott will need to decide how to handle absences. One option is to have students come in during the other double-blocks that will be held on Monday.

Next steps.

1. Jane and Elliott will want to explore the most efficient ways to link student maps into the class map. Do we want to try to have students who finish quickly

collaborate individually with Jane and facilitate adding their work to the class map WITH her as they finish their folders?

2. Student presentations. This is a great time to let ALL the students know what a great job they have done. It is a GREAT time to emphasize the KEY connections they have made and correct any misconceptions. It is a GREAT time to applaud the individual creativity that will be demonstrated with their color choices, shapes of boxes, font, etc and what those features MEAN to the map creators. It is a GREAT time to discuss features that determine good attached resources and those that don't. For instance, they will find that some of the photos they picked are TOO small to project with clarity for the whole class. Perhaps they can come up with guidelines about resolution that clarify just which resources work best. Presentations should be limited to the 3-5 minutes. BUT there should be debrief time after each presentation about the CONTENT of the biological concepts AND the appearance of the concept map. The goal would be to establish guidelines that the STUDENTS feel make for effective CMap Communications. Perhaps one student could be the class secretary for these comments.

3. Also, is there any chance of getting someone at the school to create digital video clips of students presenting their work? How about someone from the club in which students go around and visit different classes?

4. We need to have the students fill out an evaluation of their first venture into concept mapping with *CmapTools*. (As well as Elliott)

5. We need to post the student class maps so they can use them for studying.

6. We need to follow through on "permissions to use student work" for research purposes which would include writing of publications and presentations at conferences.

7. We need to decide appropriate concept map Evaluation/Feedback strategies for the students and for the LEF project. Elliott, we might discuss two goals here: one is to "give the students a grade" but another one might be to have students learn from each other's maps. Do you want them to be able to view how student teams in the other classes mapped the same organelle that they did? Or do you want them just to learn from teams in their own class? Do you want to give a particular class an award for the best class map? (We could print off certificates, for instance?) Do you want to create a "synthesis class map" that links the best individual team organelle maps from all three classes?

Appendix B5.5
Reflection: Green and Red Double Blocks
December 11, 2006

Suggested Revisions of Directions
1. Add to/edit the initial directions.
    a. Log on to the laptop computers as usual: Student/ Return/Return
    b. Locate the IHMC *CmapTools* Folder in the "Applications" folder on the hard disk.
    c. In the *CmapTools* Folder, locate and open the *CmapTools* application. Some computers require a username and password; some don't. We don't understand why that is so.
    d. An upgrade option will come up in a window. DO NOT UPGRADE. Close the window by clicking the red circle in the top left corner.
    e. Be patient and wait for the *CmapTools* window to open.

2. You can enlarge the Cmap window by clicking in the green circle in the top left corner.

3. As soon as you have created a few concept map linkages, SAVE your map to the "My Cmaps Folder."

4. The easiest way to add a resource is to "Drag" the URL or document icon over the concept word and drop. In the resource window, name the resource. Click OK.

5.   In the "Views" window, students will see their concept map AND a list of all the resources they have added. They should create a New Folder (File New Folder from the menu bar).

6. This Folder is transferred to the Cell Organelles Folder on the IHMC Public Server 2 accessed via "Shared Cmaps."

Students need to be encouraged toward hierarchy and away from create spider web type maps. Students need to be encouraged toward one-word concepts that represent a noun (usually an object, such as 'chromosome' or event such as 'reproduction.' Verbs, adjectives, and adverbs work well as "connecting words or phrases. Long phrases make the maps more like paragraphs instead of targeting specfic concepts. Words in BOLD in the textbook are likely to be important concepts to map. Whole sentences and phrases don't belong in concept boxes.

Some students do innovative mapwork with the Styles Pallette; by adding animations and/or video clips instead of still shots only; by using the Help function and learning to create "annotations." By adding copy/paste symbols from Word into the concept maps. Lists of cool innovations should be kept during class presentations. Elliott will be adding a "key mapping characteristic" column to the Table students will fill out during class presentations.

The Permissions were made as open and accessible to "Everyone" as possible. We find complex and varied results when students try to drag and drop their concept map icons from their folders in IHMC Cell Organelle Resources to the Class Concept Map. Sometimes, they make the linkage successfully. Sometimes they receive a pop-up window advising them to ask for a collaboration session. Sometimes they are asked to enter a password. Sometimes they have difficulty saving the change. It appears that the problem comes when everyone is trying to edit simultaneously. "We can't keep up with the rate of changes." We need to close down in order to "refresh" and get the new added folders.

This issue needs to be referred to IHMC to see if we can make this action more smooth. Elliott and I seem to have no problems when we go to add the student cmaps at the end of the double block.

Appendix B6

Student Concept Mapping Experience 2: C³M Team

B6.1 Student Handout: Comparing Mitosis and Meiosis with Concept Maps

B6.2 Student Handout: Creating Cell Reproduction Concept Map Using *CmapTools* Software

B6.3 Reflections on Experience 2, Day 1

B6.4 Reflections on Experience 2, Day 2

Appendix B6.1
Student Handout: Comparing Mitosis and Meiosis
with Concept Maps

We have been studying mitosis and meiosis, two related processes that lead to cell division in eukaryotes. To consolidate your learning over the next few days, we'll be creating concept maps that will allow you to compare and contrast these two processes.

Overview: You will work in pairs to create your final concept map, splitting up the early work so that the whole assignment can be completed in detail. First, you'll create a concept map using paper and pencil. One of you (Student A) will be assigned a general concept map about Cell Reproduction including (but not limited to) several concepts that will be assigned to you (in a "parking lot" of concepts). The other student (Student B) will be assigned a concept map that details the 4 stages of mitosis and the 8 stages of meiosis using concepts assigned to you as well. Both of you will put your maps together and during a double block lab, you'll create and share a computer-based Cmap using Cmap Tools (like we did earlier this year). To this you will attach a resource (e.g., web sites, images) that will be provided to you and any others you'd like to add as time allows. Finally, you will critique your own map plus a similar map created by a pair of your classmates. A pair of classmates will also critique your map.

Assignment 1 – For Homework: Student A: Create a concept map on paper with the heading "Cell Reproduction" and using the following concepts as part of your map.   Do not include the detailed phases of mitosis and meiosis in your map but do think about the different results that these two processes provide. This work will create your "base map" to which the detailed phase maps from Student B may be attached. Create clear, thoughtful crosslinks between different branches of this basemap without making the map look too messy.

Eurkaryote	*Plant Cell*	*autosomes*
Prokaryote	*Animal Cell*	*somatic cells (body cells)*
Mitosis	Cleavage Furrow	haploid (n)
Meiosis	*Cell Plate*	*sex chromosomes*
Cytokinesis	*Sexual Reproduction*	*gametes (sex cells)*
Cell Cycle	*Asexual reproduction*	*diploid (2n)*
Interphase	*G1 phase*	*organism's growth*
G2 phase	*S phase*	*tissue repair*
sister chromatids	*cytokinesis*	*chromatin*
binary fission		

Student B: Create two concept maps on paper with the headings "Mitosis" and "Meiosis" and using the following concepts as part of your maps (some may be used in both). You want to be sure to show the phases by linking to provided visual resources and the important events of each phase.

Mitosis	*Meiosis 1*	*Meiosis 2*
Prophase	Prophase 1	*Prophase 2*
Metaphase	*Metaphase 1*	*Metaphase 2*
Anaphase	*Anaphase 1*	*Anaphase 2*
Telophase	*Telophase 1*	*Telophase 2*
crossing over	*genetic recombination*	*sister chromatids*
independent assortment	*chromosome*	*homologous chromosomes*
tetrad	*chromatin*	*cytokinesis*

Teamwork: Students A and B should BOTH think of linking the cell reproduction maps to broader contexts. Can you link your maps: To other chapters that you have studied? To significant consequences if cell reproduction goes wrong? To personal experience? To your lab-inquiry work on this unit (for example, the "Time for Mitosis" lab)?

Assignment 2: (In class, beginning Tues. March 20) With your paper concept maps in hand, come together in class, go over your work and create a paper concept map that streamlines and integrates the 3 maps you've created. The "Mitosis" and "Meiosis" maps will be submaps of the larger "Cell Reproduction" map. Be sure that your final map includes the functions and phases (and key events tied to each phase) for both mitosis and meiosis and that it allows the reader to compare and contrast the similarities and key differences between the two. (You are encouraged to use cross-links and to structure your maps so that this is easier to follow.)

Assignment 3: (During double block either Fri. March 23 or Mon. March 26) With your final maps in hand, create a *CmapTools* map on the computer so that others can see it. (I'll provide details on how to do this.) You will only have the double block to complete this, so be ready. Remember to incorporate the resource(s) (I'll provide some) as part of your map.

Assignment 4: (In class during the week of March 26) Read over the rubric and complete the Self-Evaluation Form as a team when you are done (if time does not permit, do this during the next class) and hand in all maps and forms.

Assignment 5: (In class during the week of March 26) You will be assigned another map to evaluate in class on-line using the Peer Evaluation Form, which will be due during or after the Assignment 4 class.

Appendix B6.2
Student Handout: Creating Cell Reproduction Concept Map
Using *CmapTools* Software

Goals: *Practice basic CmapTools skills; create cell reproduction concept maps using CmapTools; link your mitosis and meiosis maps to your cell reproduction map.*

Part One: Reintroduction to basic *CmapTools* features and creating your maps.

Under Applications on your laptop, find IHMC *CmapTools*. Click open the application. It will ask if you want to update the software. **Do NOT do an update. Hit the red circle in the top left corner to close the update window.** Be patient while *CmapTools* opens. NOTE that *CmapTools* opens automatically in a "Views – *CmapTools*" window at the "Cmaps in My Computer" mode indicated by the selected box in the top left corner of the window. The "My Cmaps" associated with this window are the ones created on this particular laptop. Another icon on the left identifies "Shared Cmaps in Other Places". These are Cmaps in folders saved on the server in Florida that you may or may not have access to; you will be saving your final Cmap to one of these folders on the server set up for your class.

9. **Create a Folder** - First, while working under "My Cmaps" mode create a folder with your initials.
10. **Create and Name Cmaps** - Next create your concept maps. From the Menu bar, choose "File" and under it, select "New Cmap." (Today, you will create and name either the Cell Reproduction concept map or the Mitosis and Meiosis maps, depending on your assignment. Your partner will create the other map or maps. Name these as: "Mitosis" + your initials, "Meiosis" + initials and "Cell Repro" + initials (e.g., "Cell Repro EG")
11. When a blank, untitled Cmap opens, click in the center to create a concept oval. Type a concept word in the oval. You can click on and drag this concept to the top of the page. **Save your work** after a minute or two to be sure the Save function under "File" is working properly. Name it using the instructions above and save to your folder in "My Cmaps". Don't forget to keep saving as you go.
12. To create a linkage between two concepts (a propositional linkage), point and click the small box with arrows at the top of the concept oval. Drag the arrow to where you want the new concept. Label the new concept in the oval. Label the linking word in the box connecting the two concepts. Continue this with all your concepts.
13. To draw and label a crosslink, point to the arrow box at the top of a concept on one side of the map and drag it to a concept it can connect with. Label the linking word.
14. **Copy over Resources** - Once your map is complete, go to the "Shared Cmaps" icon and click on IHMC Public Server2. Wait while it loads then scroll down to the folder called "LHS Gimble HFry." Open the Cell Reproduction folder you'll see there, then the "Resources – Cell Reproduction" folder. Click all the resources listed and drag them over into your folder in the My Cmaps folder. (If

you have difficulties, you may also select "Copy to folder…" under the Edit function on the menu bar and copy the resources over to your folder in My Cmaps.) These are resources you can now add to your Concept Maps.

15. **Attach Resources** - Attach these provided resources to the appropriate places in your concept maps. As time allows, find additional resources and add them. (To add resources, such as URLs and JPEG images or documents, drag and drop your resource into the My Cmaps folder. Under "Edit" on the Menu bar, go to "Add and Edit Links to Resources". Drag the concept that you want to link into the area for adding resources. Click on the resource you want to work with and fill in the Resource Window. You can choose the type of resource under "Group" (e.g., websites are HTML Composites). You will need to put in a title. Click OK when you are done.)

16. Now drag the Resource from your "My Cmaps" folder over the concept oval where you want the resource to be linked. A small resource icon should appear at the bottom of your concept word.

17. Having difficulties? Call for help. NOTE the Cmap "Help" Function in the Menu Bar. There is a full selection of options to choose from.

Part Two: Saving your Concept Map to the Public Server2

1. **Save to the Class Folder** - When you are finished creating and saving your maps, go to the Cell Reproduction folder on the IHMC Public Server2 within the "LHS Gimble HFry" folder. Here you will find a folder with your class section color as the title. Inside that folder, create a folder named for the two sets of initials of you and your partner (e.g., "EG JF"). Drag the folder with your initials (the one on My Cmaps that contains your concept maps and resources) over to your team folder (which you just created) inside the folder named for your section's color.

2. **Attach Mitosis and Meiosis Maps** - Once your three concept maps are complete and in your team folder along with the resources you've used, you will want to attach your Mitosis and Meiosis maps to your Cell Reproduction map. With your Cell Reproduction map open, click on the Mitosis concept. Under "Edit" on the Menu bar, go to "Add and Edit Links to Resources". Click on your Mitosis map listed in the window then click on "Add to List" then click "Update." Do this for the Meiosis map as well, linking it to the Meiosis concept. Test your success by double-clicking on your Cell Reproduction concept map saved in the class folder and testing the links to resources.

Congratulations! Check in with me so I can double check your work at this point.

Appendix B6.3
Reflections on Experience 2, Day 1

Conceptual Observations:

1. Students are responsible for a much larger chunk of conceptual knowledge this time. It takes more than a double block to create and link the maps and resources.

2. Many of the students are doing vertical "flowcharts" of the mitosis and meiosis processes, and it's clear they don't have hierarchy straight in their minds. Hints that hierarchy is an issue are: repetition of concepts in the map and closed polygons where parts of the map reunite (not a crosslink).

3. While there was little to distinguish the prior tightly structured organelle maps, there is considerable variation among this set of maps. One student struggled with simple descriptions of the phases of mitosis and was clearly unprepared for the concept mapping work. Other students, however, had creative and deep questions about the relationship of 'cell cycle' to 'cell reproduction'. (This led to a faculty discussion of maps reflecting a particular focus question, in which case a more general concept, such as 'cell cycle', could actually occur farther to the bottom of the concept map than a more 'specific concept', such as 'cell reproduction', because the more specific concept was more salient to the focus question. Also the relationship of 'somatic cells' (usually associated with asexual reproduction) and 'sex cells' (usually association with sexual reproduction). BUT the nature of the queries led to the concept of the development of undifferentiated cells through meiosis to form egg and sperm. .. which is in the next unit.

4. One misconception screamed from the map: "Animal cells carry on sexual reproduction. Plant cells carry on asexual reproduction."

Technical Observations:

5. Technical: cannot access internet. Solution: Go to menu and change "transmitter" from the computer carts. There are different transmitters for the E and F carts.

6. Technical problems which appear, such as inability to save or doesn't start, disappear upon rebooting and going through the appropriate student return return protocol. One computer still has a sign up that appears automatically that requires a password, and we don't want to go that route. We want linkage among all the folders.

Random technical issue of boxes appearing rather than letters. Difficulty with choosing font. Three students had this problem. Solution is to click outside the map structure. (Select all?) Select the font. Some effort was through fiddling with Default command.

Appendix B6.4
Reflections on Experience 2, Day 2

Students continued with their mapping.

Technical challenges.
1. One computer wouldn't start up. Dead battery? Students needed to reclaim the same computer because they weren't uploaded to the public server last time.
2. One student dragged a visual to a concept, and the whole background showed the visual rather than a linkage forming. "We haven't seen that before. My main concern is not to lose all the work you've already done. Was this saved before you tried to attach the visual? No? Hm, this is the kind of technical problem that students often solve." "Student: Why don't you save it to a new map?" So we did. Delete prior version. Problem solved.
3. How to merge maps. Individual students create folders (own initials) and make links to digital resources on their own computers. One student transfers folder with concept maps and resource folder to the Public Server. The name of the folder is changed to include initials of both partners. The partner can then open the public server folders and drag their concept maps (without resource folder) to the shared folder and then make links to the partners' maps. OR The partner's map on the server can be opened and the new maps can simply be dragged and dropped onto the appropriate concept; thus adding submaps as a resource to the overall more general map.
4. Some resources disappeared from the resource folder. We need to lock the resource folder.

Conceptual/ Metacognitive challenges.
Having difficulty with different levels (hierarchy) AND with "significance"
Too big a leap for many students this time.
Biggest problem is with hierarchy.
Confusion over:
       Chromatin and how it relates to chromosomes.
       Prokaryotes and eukaryotes (plant or animal cells)
       Asexual (plant) and sexual reproduction (animal)

Logistical challenges.
       Breaking over a weekend, students were not quite ready to pick up where they had left off. They seemed to have "lost it" over the weekend.

2. Time limitations. Elliott only has two class periods before students must be tested. We agreed to give students one more class to finish up. (About 20% are already finished.)
3. Absenteeism is difficult for partners.
4. Maps are number coded and put on Elliott's website for evaluation.

Ideas

Evaluation. Have students vote for whose they'd like to link to. Evalution is kept short this time. Show Jane's. Show a student's. Self evaluate and evaluate one other: What's good? What's bad? What did you learn through this process? What would you do differently next time?

Have student print out chapter maps through the year and put them together with a "culminating event" at the end of the year.

Appendix B7

Feedback on Experience 2

B7.1 Analysis of Individual Maps; Summary of Misconceptions;
Global Reflections

B7.2 Student Self- Evaluation of Concept Mapping Experience:
Verbatim Responses

Appendix B7.1
Analysis of Individual Maps; Summary of Misconceptions; Global Reflections

Analysis: Comments on Students' Cell Reproduction Maps (Maps 1-24)
CR = Cell Reproduction Map; MIT= Mitosis detail map; MEI= Meiosis detail map

1. CR: GREAT CLEAR hierarchy; propositional linkages; crosslink of binary fission and mitosis to asexual reproduction. MIT: clear, but linkages don't open; MEI: unusal rep of phases in vertical fashion with somewhat "spaghetti linkages" across the middle of the map. Good use of color to emphasize the "backbone of the map is the phases. Details are present.

2. CR: OK, although order of phases seems "upside down" to my eye. Sister chromatids and chromatids are oddly placed and meaning is unclear. Concepts of "meiosis" and "sexual reproduction" could easily be shifted to be on the same hierarchical level of "mitosis" and "asexual reproduction." Links visuals well. Where are the submaps of mitosis and meiosis?

3. CR: This map demonstrates lack of conceptual thinking. There are sentences, some of which are correct. Note that the overall structure of the map is strung out sentences. There is NOT a sense of hierarchy of some general ideas having more detailed ideas below. No submaps of mitosis and meiosis. Clear misconceptions.

4. CR: Good, clear map with clear connections. Linkages not working.

5. CR: Puts Prokaryote and eukaryote at the top of the hierarchy, thus de-emphasizing cell reproduction. Omission: while it DOES correctly connect binary fission to asexual reproduction, it does NOT connect mitosis to asexual reproduction. Does this student assume that plant and animal cells are only using sexual reproduction? Links work. MEI: fine MIT: fine. Does this student assume cytokinesis is part of mitosis?

6. CR: Nice use of color to separate eukaryotes and prokaryotes. Many linkages are fine. However, there are some hierarchy problems. Note the polygon formed by plants cells, animals cells, and cell cycle. It is very odd to place "mitosis" so low in the map. Plant cells, cell plate, mitosis, cytokinesis, and cleavage furrow strew down the left side in a "spaghetti sentence." Yes, those words are connected, but they're not clearly presented in a hierarchical fashion. There appears to be some confusion about some of the connections. One might ask: a. How are homologous chromosomes related to the concepts of diploid and haploid? B. How are sex chromosomes related to sexual reproduction? Are they the only chromosomes involved in sexual reproduction? Should gametes, in addition to somatic cells, be linked to chromosomes? Just how are mitosis and meiosis

linked to animal cell reproduction? Good that links open up. MIT: OK; link does not open. MEI: WOW: Fabulous use of color-coding and well-organized. CLEAR connections of crossing over and independent assortment to genetic recombination (which is repeated and could easily be "cross-linked.). Nice work!

7. Nothing really.

8. 8a is just getting started. Would suggest lining up phases left to right and there need to be higher level "Meiosis 1" and "Meiosis 2" concepts. 8b has full descriptions of the phases of mitosis but they are strung out like sentences and there are MANY multiple-word bubbles. This person needs to learn to identify a "concept" and simplify the connections. This person would be happy to learn about the tool to add detailed information that is not as "salient" in a "mouse-over box."

9. CR: This map shows a lot of good thinking. There are times that two words belong on the same level, but are joined by "and" like a sentence. (For example, Autosomes and sex chromosomes.) This person claims that "asexual reproduction" occurs in some eukaryotes. I would ask "under what circumstances?" Linkages work. MEI: good crosslink between MEI 2 and Mitosis. Could work at making arrows between phases consistent. Gets a bit "spaghetti" with all the links to chromosomes and does not in detail distinguish the different forms of DNA: chromatin, chromatids, tetrads, etc. Also does not indicate where meiosis gives rise to genetic recombination. MIT: Not much detail. Good crosslink between telophase and prophase as "opposites." Links work.

10. CR: Generally, fine. The connecting words tend to be too detailed. Concise would be better. Also, compressing the concepts closer together instead of spread out so much would allow the viewer to see more of the connections simultaneously. Links do not work. The MEI and MIT maps form a concept web rather than hierarchical pattern. This appears to be done so "it will all fit." Again, being more concise with concept and linking words would reduce the need to create the spiral display. However, it IS an interesting representation to discuss. Spiral issues aside, in the MEI map, I would encourage consistency. One of MEI divisions goes clockwise, the other counterclockwise.

11. CR: Nice clear hierarchy in general. G1, S and G2 should go beneath "interphase." Ah, there seems to be an idea that an organism's growth happens during interphase. This is mixing up organismal growth with cellular growth. Very interesting. Also, there is confusion about the relationship of chromosomes to diploid number and autosomes. Again, unclear relationships among gametes, haploid, and sex chromosomes. Missed an opportunity to crosslink asexual reproduction via mitosis and binary fission. Most links open. Why is human life cycle linked to somatic cells? MEI: OK. Plenty of detail. Strung out vertically. Could be more concise. Two visuals OK. Where is visual for Meiosis I? MIT: fine. Try to minimize number of words in each bubble. Links work.

12. 12aMIT: OK. Has all the phases. Some of the linking words are not clear. Needs spellcheck. There are no attached visuals. I would want this person to explain their map to me verbally. 12b MEI 2: OK: Strewn lengthwise, so not sure if students understand connections among these three maps. 12c: MEI1: good understanding of crossing over giving rise to genetic recombination and that "haploid" begins in Anaphase 1.

13. CR. Some good thinking here. Overall shows hierarchical structure although not as integrated as some. (For instance, animal and plant cells with cleavage furrow and cell plate are NOT integrated with cytokinesis.) Chromosomes when duplicated become "sister chromosomes." Well, it's "sister chromatids." My only concern is that they might be mixing up sister chromatids with homologous chromosomes. A verbal explanation from the students would clarify their thinking. Very interesting to put both mitosis and meiosis underneath cell cycle. What do you think of that, Elliott? Works for me, but it's NOT what I would have put. I mean, after all, developmentally, don't cells go through interphase before meiosis as well as mitosis? However, I don't think you'll see any biology texts putting it quite this way! Frankly, I think it shows some thought! I don't see growth, repair. Hm. Mitosis and meiosios are repeated. . . .not necessary. Links work. MIT: clear mapping. BUT shows improper description of chromosome behavior during prophase and metaphase! Especially bad since the correct metaphase figure is attached! MEI: OK, but would be better to link independent assortment and homologous chromosomes with Metaphase 1.

14. CR. Hm. Seems to be some confusion and misconceptions here. When students say, "Chromosomes 'divide' into sister chromatids, what do they mean?" It's more like multiplication than division, isn't it? Hierarchy issues: Cell cycle includes mitosis and cytokinesis. This map has cell plate over with binary fission instead of with cytokinesis. This map does not connect cleavage furrow with animal cells and cell plate with plant cells. "Sexual reproduction includes somatic cells that consist of sister chromatids which are two chromosomes called homologous chromosomes which split into autosomes and sex chromosomes." That's confusion! "Humans have haploid cells and diploid cells" doesn't tell me much! This student has some sorting out to do! MIT: fine. Vertically oriented phases. Links work. MEI: BEAUTIFUL with vertical alignment of phases and color coding of Meiosis 1 and Meiosis 2 and shading of concepts. Independent assortment is excluded. This is particularly interesting since the map says "maternal and paternal chromosome pulled to opposite sides," which makes me think this student is MISSING the idea of independent assortment. Links work.

15. CR: tendency to string sentence-like rather than branch and cluster concepts. Animal and plant cells are oddly positioned. . . OK connection to eukaryotic cells, but would be better served where they have cytokinesis. Cleavage furrows and cell plates should have "parallel connections" to cytokinesis. Good crosslink to asexual reproduction between mitosis and binary fission. Cell cycle visual opens, but map does not reflect its hierarchy. MIT: "Anaphase moves independent assortment." That makes no sense. Vertical arrangement is clear, however. MEI 2: vertical. . . clear. Independent assortment concept needs to be clarified.

16. 16aMEI Nice color coding. Clear visual presentation. Good linkage of crossing over with genetic recombination; independent assortment appropriately linked. "Tetrads line up on equator" needs to be shifted left under metaphase. Currently positioned under anaphase. . . although the linkage is to "tetrads" rather than directly to the phase. Good crosslink to mitosis in the second division of meiosis. Links to visuals work. Very interesting map to view. 16bMIT: beautiful map with one very clear misconception: "Homologous chromosome pairs align at the equator in metaphase of mitosis." These detail maps are not linked to a CR map.

17. As with one prior map, this map shows the cell cycle comprised of interphase (its subunits) leading to either mitosis or meiosis. This map shows a lot of thought. Note that interphase is linked to tissue repair and "cell" growth. . . unlike a prior map that linked interphase to organismal growth. Still worth addressing this idea. Binary fission is not linked to prokaryotes. MEI: OK Vertical orientation. MIT: Fine. Attachments work.

18. CR Attractive background color. Sexual and asexual reproduction not integrated with other concepts. Concepts under meiosis don't make particular sense. Relationship of chromosomes and chromatids and chromatin are unclear. Function of mitosis is clear. Cytokinesis is not seen as part of "mitotic phase, but is on some level of hierarchy as "interphase." MEI: The strength of this map is the budding connections of crossing over with genetic recombination. Independent assortment should be linked with Metaphase I. The listing of phases is weak from a mapping point of view and no details are offered about what is happening. No visual links. MIT: Misconception: Prophase contains homologous chromosomes. Anaphase happenings are unclear.

19. Some good thinking here. Good general hierarchy. Mitosis needs to be linked to the cell cycle. "Sex chromosomes and autosomes divide into sister chromatids for division during prophase." That's a problem. Links work. No connections to mitosis and meiosis detail maps.

20. CR Some hierarchy problems. Cytokinesis should be higher. (note the polygon shape that is created.) "Sexual reproduction occurs through the cell cycle." Confused relationships among cytokinesis, sister chromatids, chromatin, autosomes, sex chromosomes. Meiosis produces both haploid and diploid. Somatic cells are linked to meiosis, while a link to mitosis would be more appropriate. Links work. MIT: linear lacking in detail. Needs "mitosis" at the top. MEI: Although this is a bit "strung out," I think they've "got it." This map, although it's a bit confusing, DOES seem to clarify the relationship of crossing over and independent assortment to genetic recombination!

21. CR: Red! Mitosis is not connected to cell cycle! Understands relationship of mitosis to diploids and somatic cells. . . not everyone got that! Does not connect plant cells with meiosis, only animal cells. Strings together concepts under

meiosis (sentence-like). Interestingly, cell cycle is located ABOVE the split in asexual and sexual reproduction. We've seen this before! MIT: clear. Needs to review relationship of telophase to cytokinesis. Good links. MEI Very pretty map, again. Very clear with color coding. However, there are two prophase II concepts. Also, this student needs to rethink the connections of independent assortment to other concepts. Links work.

22. CR Colorful! Many good individual connections. Could use some more integration work. For instance, mitosis is not connected to cell cycle. The connection between mitosis and asexual reproduction is not made. Again, cytokinesis is found under telophase. What is odd is the claim that all the phases occur "in cell," except for prophase which occurs "within chromosome." Also, the role of sister chromatids is very confused in prophase and metaphase. Attachments work. MEI: "A tetrad is four chromosomes." Needs to clarify "chromatids, sister chromatids, sister chromosomes." Attachments work.

23. CR Mitosis is not linked to its phases as part of the cell cycle; nor is it linked to asexual reproduction. Doesn't distinguish the differing roles of mitosis and meiosis clearly. For instance, "cell reproduction" is responsible for growth and repair. . . not just mitosis. "Meiosis produces sex chromosomes." Needs more integration: plant cells with cell plate and animal cells with cleavage furrow need to be linked to the appropriate phase. Links work. MIT: OK. Spell check. Check relationship of telophase to cytokinesis. Attachments work. MEI: Very nice. Very clear. Has two connected maps with Mei 1 and Mei 2. However, Mei 1 needs to include genetic recombination, crossing over, and independent assortment.

24. CR: Some hierarchy issues: Asexual rep., sexual rep., binary fission, and cell cycle are all on the same level, for instance. A bit spindly and needs more clear branching. Attachments open! Bad news is mitosis is not linked to the cell cycle. "Somatic cells are autosomes." MIT: needs clarification of linking words. What happens in metaphase? Spellcheck. MEI: Spellcheck. Relationship of independent assortment and crossing over and genetic recombination needs to be clarified.

Summary of Misconceptions

1. Cell cycle occurs in eukaryotes, but not prokaryotes. 3
2. G1, G2, S are considered "in addition" to interphase rather than subsets of interphases. 3
3. Binary fission is a form of sexual reproduction. 3
4. "Diploid are autosomes." Doesn't understand that a full set of chromosomes whether diploid or haploid includes both autosomes and sex chromosomes.
5. Cytokinesis is part of telophase. (many maps)
6. During prophase, chromosomes pair up. 9
7. Haploid cells include somatic cells.
8. Diploid have autosomes; gametes have sex chromosomes 11

9. Interphase "this happens" organism's growth. 11
10. There is a lot of confusion about sexual reproduction, sex chromosomes, and chromosome number.
11. Meiosis 2 still has homologous chromosomes. 11
12. Chromosomes when duplicated become "sister chromosomes." 13
13. Prophase is when chromosomes line up on the equator. They come apart in metaphase. 13
14. Eukaryotic cells are animal cells and prokaryotic cells are plant cells. 14
15. Animal cells undergo asexual reproduction and humans undergo sexual reproduction. 14
16. Sexual reproduction includes somatic cells that consist of sister chromatids which are two chromosomes called homologous chromosomes which split into autosomes and sex chromosomes.
17. Diploid nucleus whose pairs are autosomes. What does that mean? 15
18. "Meiosis makes gender-determining sex chromosomes." 15
19. "Anaphase moves independent assortment." 15
20. "Homologous chromosome pairs align at the equator in metaphase of mitosis." 16a
21. Prophase contains homologous chromosomes. 18
22. "Sex chromosomes and autosomes divide into sister chromatids for division during prophase." 19
23. "Sexual reproduction occurs through the cell cycle." 20
24. Meiosis produces both haploid and diploid. 20
25. All the mitotic phases occur "in cell," except for prophase which occurs "within chromosome." 22
26. In mitosis, the role of sister chromatids is very confused in prophase and metaphase. 22
27. "A tetrad is four chromosomes." 22
28. Meiosis produces sex chromosomes. 23
29. "Somatic cells are autosomes." 24
30. "Gametes have sex chromosomes." This implies that Diploid cells do NOT have sex chromosomes.

Global Reflections

In the future, I would have students concept map what happens to the chromosomes on the detail maps and put the spindle, nuclear membrane details on a mouse over. They are NOT essential. While **connecting crossing over and independent assortment to sexual reproduction and genetic recombination and meiosis (I) IS essential. (Many students are omitting independent assortment and genetic recombination from their Meiosis maps.)** It is interesting that while linkages are often correct, the most important linkages (salience) are sometimes missed.

Commonly confused concepts. The relationship between telophase and cytokinesis is unclear. For many students the hierarchical relationship of cell cycle to interphase (and its subsections) and mitotic phase (and its subsections) remains unclear. The relationship of chromatin and chromosomes, sister chromatids, and homologous chromosomes challenges many students. The introduction of sex chromosomes and autosomes at this point has created a lot of confusion. They don't know what those concepts have to do with haploid and diploid, with mitosis and meiosis.

Appendix B7.2

STUDENT SELF-EVALUATION OF

CONCEPT MAPPING EXPERIENCE

(N = 50)

Verbatim Responses

Concept Map Student Self-Evaluation: Blue Class

Map Number: 27

Map Effectiveness
Color coding
Good linking words

Map Suggestions
Reduce "stretched out"
Add crosslinks

Cmap Learning Process
Understand crossing over and its significance

Cmap Learning Suggestions
Learning how to set up the map

Map Number: 26

Map Effectiveness
Color coding
Good organization of linking and vocabulary words

Map Suggestions
Not as stretched out
Use crosslinks- meiosis map

Cmap Learning Process
Deeper understanding of concept by using a camp because you have to have extensive knowledge to complete a cmap

Cmap Learning Suggestions
Figuring out placement/connections with the words.
Saving to server was complicated. Some got cut off on the Cell Respiration map.

Map Number: 32A, 32B

Map Effectiveness
Easy flow and clarity of transitions
Complete description of the formation using minimal words (concise)
Color arrangement

Map Suggestions
Nothing

Cmap Learning Process
Learned differences between mitosis and meiosis
Learned that concept maps help me understand comparisons.

Cmap Learning Suggestions
Liked working alone, but it would have been nice to have a partner who could help at some times.

Map Number: 28

Map Effectiveness
A lot of information that helps with tests or quizzes.
Good linking words

Map Suggestions
Include mitosis.
More time.

Cmap Learning Process
I don't like doing concept mapping.

Cmap Learning Suggestions
Don't assign it or do it only once.
Note: check and correlate comments with map 28. (Chris Reyes and John Taves.)

Map Number: 28

Map Effectiveness
A lot of information put in a way that easier to understand (clarity)
Good linking words

Map Suggestions
Include mitosis.
Make it more organized maybe. . .

Cmap Learning Process
The cell cycle is a huge part of cell reproduction.
Concept mapping is a long process if there are many words to link.

Cmap Learning Suggestions
It was hard to link things.
Give us one more day.

Map Number: 26

Map Effectiveness
Our connections are very detailed.
Our pictures are accurate and detailed.
Pictures enable better understanding.

Map Suggestions
Make less confusing by making links shorter and overall picture smaller.
Make easier to read by lining up main parts. (organization)

Cmap Learning Process
By making a concept map yourself, you understand more of the connections and the overall picture.

Cmap Learning Suggestions
Difficult using all the vocabulary words.

Map Number: 25

Map Effectiveness
Good use of resources (cell reproduction). (pictures)

Map Suggestions
On mitosis and meiosis, get rid of "?????." Needs transition words.

Cmap Learning Process
Nothing

Cmap Learning Suggestions
How to use transition words to connect the ideas
Note: Check map.

Map Number: 2

Map Effectiveness
There are not a lot of cross-connections, which make the basic concept map more clear.
Linking words are clear and concise.

Map Suggestions
More spread out
Eukaryotes farther from prokaryotes
More cross-connecting ideas.

Cmap Learning Process
I learned how complicated cell reproduction is and that I don't learn well from concept maps.
Note: check map.

Cmap Learning Suggestions
Organizing such a complex concept was difficult.
Taking more time in class would have made it easier.

Map Number: 31

Map Effectiveness
Clean and easy to read.
Accurate

Map Suggestions
More information o meiosis and mitosis maps.
Make the links work.

Cmap Learning Process
I'm not very good at concept mapping.
Note: check map.

Cmap Learning Suggestions
Finding which things to link to which things.

Map Number: 31

Map Effectiveness
Ours is clean and easy to read. (clear)
Links make sense, are brief, but accurate.

Map Suggestions
Could have included more media links, but overall were satisfied.
Link Sean's map.

Cmap Learning Process
I learned how numerous processes were connected.

Cmap Learning Suggestions
My partner was absent for one working block, so we were behind.

Map Number: 33

Map Effectiveness
Very neat and orderly
Mostly correct connections

Map Suggestions
Not enough cross connections.
Inconsistent capitalization.

Cmap Learning Process
I learned how specific terms affect the processes of mitosis and meiosis.

Cmap Learning Suggestions
I needed to learn about my topic before making the map. Maybe the concept map can be made after the test.

Map Number: 33

Map Effectiveness
Very neat
Organized, not cluttered

Map Suggestions
We need more and better cross connections.
Capitalization consistency.

Cmap Learning Process
I learned that concept maps help organized concepts in an easy and manageable fashion.

Cmap Learning Suggestions
What was difficult was the decision on how to exactly order each component.

Map Number: 1

Map Effectiveness
Detailed
Organized; easy to understand

Map Suggestions
Less complicated (both mitosis and meiosis)
Make it prettier (both of them): color-coded, more links, etc.

Cmap Learning Process
I learn visually.
Learned/ made connections between concepts that I didn't notice before.

Cmap Learning Suggestions
Connecting ALL concepts together.
Saving to Florida server, copying resources, was confusing.

Map Number: 1

Map Effectiveness
Detailed
Well organized

Map Suggestions
Make it less complicated.
Make it more colorful.

Cmap Learning Process
I learn visually.
I don't like concept mapping. It takes too much time.

Cmap Learning Suggestions
Not enough time. Get more time.
Connecting ALL of the concepts together.

Concept Map Student Self-Evaluation: Red Class

Map Number: 18

Map Effectiveness
The set up of the information is clear and not overwhelming.
The bold font makes it easier to read.

Map Suggestions
More pictures.
Make mitosis map a little less confusing. (Simplify)

Cmap Learning Process
Pictures are helpful in learning about cell reproduction.

Cmap Learning Suggestions
Having to keep saving and starting from the beginning.

Map Number: 15

Map Effectiveness
The links work well.
Clearly readable.

Map Suggestions
Our map is perfect. No changes.

Cmap Learning Process
I learned how cells divide.
I learn well visually.

Cmap Learning Suggestions
Putting maps and jpegs together into one folder.

Map Number: 19

Map Effectiveness
Easy to follow/straightforward
Covers a wide range of material.

Map Suggestions
Finish/ input mitosis and meiosis.
Add more resources.

Cmap Learning Process
It made the idea of cell reproduction clear, straightforward, and organized.

Cmap Learning Suggestions
Difficult working with partners and putting the maps together.

Map Number: 23

Map Effectiveness
Well organized
Useful pictures

Map Suggestions
Fix the error on the concept map.
Make the words shorter.

Cmap Learning Process
Can find the important key words about cell reproduction.

Cmap Learning Suggestions
Difficult finding important key words.

Map Number: 19

Map Effectiveness
Easy to understand.

Map Suggestions
Add mitosis/ meiosis. **(Note: ??)**
Add more resources.

Cmap Learning Process
Concept mapping is difficult.

Cmap Learning Suggestions
More time for adding resources.

Map Number: 1

Map Effectiveness
Easy to follow
Straight forward
Clear

Map Suggestions
Explain abbreviations
A few more visuals

Cmap Learning Process
Organization helps me understand things better.

Cmap Learning Suggestions
Nothing

Map Number: 18

Map Effectiveness
The set up of information: clear connections
Bold font makes it easier to read

Map Suggestions
More pictures
Mitosis: less crossing lines.

Cmap Learning Process
Pictures are very helpful in understanding the concept.

Cmap Learning Suggestions
Havingto keep saving and starting from the beginning

Map Number: 21

Map Effectiveness
Good use of all the key words and are ablet to relate many of the topics

Map Suggestions
The bubbles do not always progress downwards.

Cmap Learning Process
Concept mapping can help you learn how things relate to each other.

Cmap Learning Suggestions
It's hard to organize everything where there is so much to write about.

Map Number: 16a, 16b

Map Effectiveness
Simple and precise
Clear not confusing
Nice colors/ color-coded
Not too much text.

Map Suggestions
On the mitosis map, I would make all connections have arrows and connect the meiosis map to meiosis II
as a resource.
On the meiosis map I would make it more clear that tetrads line up during metaphase I.

Cmap Learning Process
I like making these maps because it helps me organize everything in my head. They are very helpful
and I like to make them, too.
Note: check this one.

Cmap Learning Suggestions
Partner hasn't been here the whole time, so I haven't seen a cell reproduction map. Besides that, nothing.

Map Number: 14

Map Effectiveness
The ideas interconnect.
Color division in meiosis section.

Map Suggestions

Some concepts are in the wrong area/ section.
Make more readable/ more organized.

Cmap Learning Process
I learned about the ways of reproduction: meiosis and mitosis.

Cmap Learning Suggestions
Organizing my map was hard and trying to make it look neat and organized.

Map Number: 15

Map Effectiveness
We were able to make all the links work, and the map is very readable.

Map Suggestions
Our map is perfect: no improvements needed.

Cmap Learning Process
I was able to learn more in depth about cell division.

Cmap Learning Suggestions
Joining the maps into one folder.

Map Number: 24

Map Effectiveness
The way things link up/ organization of the web. The way the maps link together.

Map Suggestions
More detail.
More resources.

Cmap Learning Process
I learned a lot more about cell reproduction as a whole; this will help with the upcoming test.

Cmap Learning Suggestions
I wasn't exactly in the know about cell reproduction.

Map Number: 14

Map Effectiveness
Cell reproduction map interceonnects all the ideas.
Use of color to make meiosis map easier to read

Map Suggestions
Some concepts are misused or in the wrong place.
Make the map more readable and accessible.

Cmap Learning Process
Cell reproduction map helped me better understand and connect concepts.

Cmap Learning Suggestions

The text did not ??? when making my concept map.

Map Number: 22

Map Effectiveness
The color is fine.
A lot of information.

Map Suggestions
Meiosis: too messy.
My map is confused.

Cmap Learning Process
???????

Cmap Learning Suggestions
Need more time.

Map Number: 22

Map Effectiveness
Colors used in cell reproduction concept map.
Good information.

Map Suggestions
For meiosis concept map: make neater.
Organize cell reproduction concept map better.

Cmap Learning Process
Making a concept map reinforces what we are learning.

Cmap Learning Suggestions
Putting together the concept map/ using the program on the computer was difficult.

Map Number: 20

Map Effectiveness
The number of connections up top really shows how all the concepts relate.
Shows how the concepts are interconnected. . .

Map Suggestions
Mitosis map is too linear: more info should be added to specific processes.
Sometimes Cell Reproduction map listed processes, but didn't explain how they were connected.

Cmap Learning Process
Mitosis builds body cells. Meiosis makes sex cells.

Cmap Learning Suggestions
It would have been easier if more concepts were originally listed on part B.

Map Number: 20

Map Effectiveness
Meiosis: connections at top are intricate: show multiple connections between concepts.
Shows separation of meiosis and mitosis, but shows connections through repeated concepts. (way maps link)

Map Suggestions
Mitosis: too linear
Concepts important: big map has many connections, but is almost like a list.

Cmap Learning Process
Cell reproduction includes mitosis/meiosis: different processes, but all come together for cell growth and tissue repair in the body.

Cmap Learning Suggestions
I think we should have been given more resources (pictures, etc) so visual learners could understand it more fully.

Map Number: 24

Map Effectiveness
Organization of web
The linkage between ideas

Map Suggestions
More detail
More resources

Cmap Learning Process
I learned about cell reproduction and all the details.

Cmap Learning Suggestions
It was unclear to me about the steps of cell reproduction.

Map Number: 12

Map Effectiveness
Helpful
Nice to look at.

Map Suggestions
Binary fission and prokaryotes should be connected.
Spacing (arrows overlap causing confusion.)

Cmap Learning Process
I learned how to more effectively use the concept map tool.

Cmap Learning Suggestions
Give more time to work on the concept map in class. Maybe have a draft that the teacher could critique and the student could later fix.

Map Number: 17

Map Effectiveness
Helpful way to figure out Cell Reproduction
Information was well-organized.

Map Suggestions
Cell reproduction: fix binary fission and prokaryotes

Cmap Learning Process
Learned how to more effectively use *CmapTools*.

Cmap Learning Suggestions
Maybe pick partners next time.

Map Number: 21

Map Effectiveness
Good use of key words and ideas; includes all of them.
Relate many of the topics to each other.

Map Suggestions
Visual organization of reproduction map could be improved
No cross links on meiosis maps; bland

Cmap Learning Process
I learned that binary fission is how asexual organism reproduce.
I learned how cellular reproduction/ cell cycle/ mitosis and meiosis relate and tie together on a broad view.

Cmap Learning Suggestions
The word bank restricted how I made the map too much.

Concept Map Student Self-Evaluation: Green Class

Map Number: 13

Map Effectiveness
Abundance of information
Nicely linked

Map Suggestions
Make it less confusing
Refine information to make it less overwhelming.

Cmap Learning Process
It helped me solidify my understanding of all aspects of cell reproduction.

Cmap Learning Suggestions
Intricacies of the server; transferring pictures is tedious.

Map Number: 5

Map Effectiveness
It showed connection and details of cell reproduction.
The crosslinks that connected the different maps.
Note: check this

Map Suggestions
On the cell reproduction amd mitosis maps I would like to make the concepts more neatly organized.
I would like to use better linking words.

Cmap Learning Process
I learned the vocabulary involved in cell reproduction.

Cmap Learning Suggestions
Using all the vocabulary on the map was difficult. It could be improved by making the vocab more easy to tie together.

Map Number: 5

Map Effectiveness
I like how all the small details were connected together to summarize the whole concept of Cell Reproduction through binary fission, sexual reproduction, meiosis, and mitosis.
I like how the most general concepts were eukaryotes and prokaryotes.
I like the crosslinks in the mitosis map.

Map Suggestions
I would organize the concepts more and find better linking words or phrases.
I would probably switch the order of particular subjects and avoid repetition.

Cmap Learning Process
I learned how mitosis, meiosis can related through cell reproduction and the specific differences with the processes.

Cmap Learning Suggestions
I found it hard to fit in certain topics.

Map Number: 6

Map Effectiveness
A lot of cross links
Meiosis and mitosis maps very clear.

Map Suggestions
Make the cellular respiration map less confusing. (Means "reproduction.")
Meiosis to mitosis maps: better linking words.

Cmap Learning Process
How everything fits together

Cmap Learning Suggestions
Linking all the words together: finding the right linking words

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Map Number: 6

Map Effectiveness
It is very clear
Has cross-links.

Map Suggestions
Make Cell reproduction less confusion.
Better linking words for mitosis and meiosis maps.

Cmap Learning Process
It was Okay, I think that this helped a little bit with how I learned, but not a lot.
Note: check this.

Cmap Learning Suggestions
Not too difficult.

Map Number: 8A/8B

Map Effectiveness
It was clear and in great detail.

Map Suggestions
Spelling.
Need to finish.

Cmap Learning Process
I learned how to make an awesome concept map.
Note: check this.

Cmap Learning Suggestions
It was difficult to somehow link everything together.

Map Number: 11

Map Effectiveness
I like the organization of the map.
How it flows smoothly into meiosis from cell reproduction.
For the mitosis/meiosis maps, I liked the organization and the connections.

Map Suggestions
In the meiosis map, I had too much detail; I'd take some out.

Cmap Learning Process
Concept mapping shows me the relationships between topics visually rather than lecturing.

Cmap Learning Suggestions
It was a lot to do in a short amount of time.

Map Number: 4

Map Effectiveness
It is lined up nicely and very neat.
It is very detailed.

Map Suggestions
Better linking words that are clearer.
Avoid awkward phrasing.

Cmap Learning Process
How mitosis and meiosis tie together.

Cmap Learning Suggestions
The computers didn't work very well.

Map Number: 9

Map Effectiveness
A lot of information
The information is tied together which makes it easy to read, especially in the mitosis map.

Map Suggestions
More detail.
The cell reproduction map could be clearer.

Cmap Learning Process
I learned a lot about cell reproduction: what is involved in what process; the differences between mitosis and meiosis, etc.

Cmap Learning Suggestions
I don't like concept mapping because it is hard to make connections between topics. Also, I didn't know the information I was mapping, so I was learning as I went.

Map Number: 7 BUT assessing 24 (Therefore, disregard 1-2)

Map Effectiveness

Map Suggestions

Cmap Learning Process
Camp can mess up sometimes.
Textbook doesn't always explain everything the way you want/need it to.

Cmap Learning Suggestions
Technical issues

Map Number: 7, but assessing 24 (DISREGARD 1 and 2)

Map Effectiveness

Map Suggestions

Cmap Learning Process
I learned cell reproduction is all linked.

Cmap Learning Suggestions
Cmap Program technical issues

Map Number: 12 a,b,c

Map Effectiveness
Interconnections
Unconfusing layout

Map Suggestions
More colorful
Different line styles to link.

Cmap Learning Process
I don't find concept maps very useful.
Note: check map

Cmap Learning Suggestions
It's difficult to make something you don't often use, so it was kind of confusing.

Map Number: 10

Map Effectiveness
Cell reproduction: linking the phases of the cell cycle in an understandable way
The mitosis map has a lot of information on each specific phase, gaining an understanding of the steps and connections.

Map Suggestions
Make meiosis/mitosis maps more simple and make more connections.

Cell reproduction: add more information and make more connections.

Cmap Learning Process
I learned the breakdown of cell reproduction and mitosis and meiosis. It makes it easier to recognize the steps and information.

Cmap Learning Suggestions
Finding how each key word/ step is linked or connected to the other steps. To improve, have less necessary key words.

Map Number: 10

Map Effectiveness
The cell reproduction links the phases of the cell cycle in an understandable way.
The mitosis and meiosis have a lot of info for each phase.

Map Suggestions
Mitosis and Meiosis maps should be more simple and more connections.
Cell reproduction maps should have more information and more connections.

Cmap Learning Process
I learned that connecting familiar concepts together helps me remember.

Cmap Learning Suggestions
Connecting every concept together was hard; have less necessary concepts in the map.

Map Number: 9

Map Effectiveness
There is a lot of information.
Information is tied together to make it easy to read.

Map Suggestions
More detail
Clarity

Cmap Learning Process
That everything is connected in some way to something else.

Cmap Learning Suggestions
Get the information down earlier.

Map Number:
Map Effectiveness

Map Suggestions

Cmap Learning Process

Cmap Learning Suggestions

Concept Map Self-Evaluation

Name: _____ Section _____ Map Number: _____
Partner's name: _____

Together look at your map(s) and answer the first two questions together and Questions 3 and 4 independently:

1. List at least two things about your map that you like or that you feel make it a useful and effective concept map:

2. List at least two changes you would make to improve your map or maps (be specific about which map you are referring to):

3. What did you learn out of this process, either about cell reproduction, concept mapping, or how you learn?

4. What about this assignment was difficult for you and how could we improve it for future classes?

Concept Map Self-Evaluation

Name: _____ Section _____ Map Number: _____
Partner's name: _____

Together look at your map(s) and answer the first two questions together and Questions 3 and 4 independently:

1. List at least two things about your map that you like or that you feel make it a useful and effective concept map:

2. List at least two changes you would make to improve your map or maps (be specific about which map you are referring to):

3. What did you learn out of this process, either about cell reproduction, concept mapping, or how you learn?

4. What about this assignment was difficult for you and how could we improve it for future classes?