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Supplemental Materials

Concept Mapping: How Visual Connections Can Improve Learning

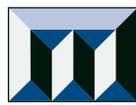
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Presented by:

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Her areas of focus include active and participatory learning, professional development for organizations, use of self-directed learning, problems and cases in real-world settings, instructional and narrative skills, and students as active collaborators in the scholarship of teaching and learning.



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Concept mapping: Practical and background information

Disciplines in which concept maps have been used, from the literature and web

Art History
Astronomy
Biology
Business
Chemistry
Computer software evaluation
Counseling Psychology
Earth and Ocean Sciences
Education
Educational Development
Educational Multimedia
Educational Psychology
Engineering
Environmental Education
Geology
History
Information Science
Instructional Design
Language Acquisition
Law
Literature
Mathematics
Nursing
Philosophy of Science
Physics
Policy Studies
Program Planning
Psychology
Science Education
Social Sciences
Social Studies
Statistics
Story-telling
Teaching Education
Technical Preparation
Veterinary Medicine
Wellness
Writing

See

<http://cmc.ihmc.us/cmc2010papers/THE%20UNIVERSALITY%20AND%20UBIQUITOUSNESS%20OF%20CONCEPT%20MAPS.pdf> for a full list and references to the literature, or contact me

Contexts:

Brainstorming
Cooperative learning
Course assignment
Course outline/syllabus
Discussion
In-class activity
Interpretive essays
Lesson Planning
Needs assessment
Noting taking at seminar/lectures, meetings
Project planning
Readings
Research
Study notes

Create a concept map using these concepts:

You can add a concept or two if it helps to complete your concept map. Be sure to add words to the arrows or lines to make the connection between concepts!

Bird
Cat
Dog
Goldfish
Horse
Indoors
Outdoors
People
Pets
Stable
Water

Types of concept maps

Spoke: a radial structure where all related concepts are linked to the main or key concept, which is in the middle, but not directly linked to each other (Kinchin and Hay, 2000, p. 47; Kinchin, 2000, p. 43; *e.g.* Slides 38, 61 and 70 in the Cassidy PowerPoint)

Chain: a linear sequence of understanding in which each concept is only linked to those immediately above or below (Kinchin and Hay, 2000, p. 47)

Tree: a structure that usually has the key concept (*e.g.* Slide 11 in the Cassidy PowerPoint, Gaines and Shaw, 1995, p. 2)

Net: a highly integrated and hierarchical network demonstrating a deep understanding of the topic (Kinchin and Hay, 2000, p. 47, 53; Kinchin, 2000, p. 45)

Web: a highly integrated network that is not necessarily hierarchical (e.g. McClure *et al.*, 1999, p. 479; Nicoll *et al.*, 2001, p. 864; e.g. Slide 37 in the Cassidy PowerPoint)

Center Focus: a simple or complex structure where the main or key concept is in the middle (e.g. Slides 52 and 58 in the Cassidy PowerPoint)

Wheel: a structure in which the main or key concept is in the middle, with related concepts linked to it (the same as a spoke), but now with those related concepts linked to each other as well (e.g. Rafferty and Fleshner, 1993, p.27; Todd and Kirk, 1995, p. 344)

Visual metaphor: a structure of any type that also depicts the very concept it is explaining, such as a combustion engine, the cell of a living organism, a genealogy tree, or a leaf (e.g. Slide 50 in the Cassidy PowerPoint)

Step by Step instructions to make a concept map

(adapted in part from Ault (1985, in Rafferty and Fleshner, 1993 and Todd and Kirk, 1995 and from Novak, 1998.)

1. Note, on paper or electronically, the concepts you wish to include
2. Rank or order the concepts; starting with a key or main concept you wish to emphasize
3. Step 2 might help you choose the type of concept map to construct (e.g. chain, tree, center-focus....)
4. Step 3 helps you decide where to place your first concept on the page
5. Decide where to cluster or arrange the rest of your concepts
6. Add these concepts, one by one
7. Connect the concepts with lines or arrows
8. Label the lines or arrows with one or a few words to describe relationships between concepts
9. Add more concepts if needed
10. Review your completed concept map and re-arrange/re-work it, if necessary, by adding, subtracting or changing concepts.

Bloom's Taxonomy: A Hierarchical Classification of Understanding: An example from Kurt Grimm, Earth and Ocean Sciences, University of British Columbia (adapted from Bloom (1956))

Key aspects to include in your concept map (the competence is listed in the numbered list, followed by the skills demonstrated in your concept map and question cues to help you create it):

1) Knowledge is the foundation for all learning. It provides a basis for all higher levels of thinking, but is rote in nature.

observation and recall of information
knowledge of dates, events, places
knowledge of major ideas
mastery of subject matter

Question Cues: list, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where,

2) Comprehension means understanding the basic information and translating, interpreting, and extrapolating it.

understanding information
grasp meaning
translate knowledge into new context
interpret facts, compare, contrast
order, group, infer causes
predict consequences

Question Cues: summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend

3) Application means using information, ideas, and skills to solve problems, then selecting and applying them appropriately.

use information
use methods, concepts, theories in new situations
solve problems using required skills or knowledge

Questions Cues: apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover

4) Analysis means breaking apart information and ideas into their component parts.

seeing patterns
organization of parts
recognition of hidden meanings
identification of components

Question Cues: analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer

5) Synthesis involves putting together ideas and knowledge in a new and unique form. This is where innovations truly take place.

use old ideas to create new ones
generalize from given facts
relate knowledge from several areas

predict, draw conclusions

Question Cues: combine, integrate, modify, rearrange, substitute, plan, create, design, invent, what it?, compose, formulate, prepare, generalize, rewrite

6) Evaluation is the highest level in Bloom's Taxonomy. It involves reviewing evidence, facts, and ideas, then making appropriate judgments.

compare and discriminate between ideas
assess value of theories, presentations
make choices based on reasoned argument
verify value of evidence
recognize subjectivity

Question Cues: assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize

An interesting example on the web:

1957, example of a concept map done by Walt Disney (even though it seems to be linked from a mind map website!)

Do you think it is authentic?

Why do I say it is a concept map rather than a mind map? Visit:

<http://www.mind-mapping.org/images/walt-disney-business-map.png> and if that URL does not work, go to http://en.wikipedia.org/wiki/Concept_map then scroll to the Disney link.

Concept mapping dos and don'ts

Do:

- ✓ Use the Step-by-Step Instructions until it becomes second nature
- ✓ Start out simple; you can always add more concepts or more detail later
- ✓ Start with a mind map (no descriptions between the terms) if it helps to get things rolling; (mind maps can be most useful for such things as brainstorming or showing how you are grouping related ideas)
- ✓ When creating a CM by hand, try using small sticky notes so you can move things around on the paper
- ✓ Use color to help explain concepts and relationships
- ✓ Add images from clipart, magazine clippings, or your own material, if it adds information or clarity
- ✓ Show your draft concept maps to others and ask for their feedback

Don't:

- ✓ Be afraid to play with your CM – you can always start again
- ✓ Use long phrases on your arrows to explain relationships (if you are doing this, it might mean you need to add more concepts, or change the direction of the arrows)
- ✓ Use color just for the sake of using color; ask yourself what it signifies or adds
- ✓ Add too much information; simpler is usually better
- ✓ If you find you have too much on one map, make multiple inter-related maps

- ✓ If you find starting concept mapping using online software to be frustrating, switch to paper
- ✓ Give up! Look at more examples; talk with colleagues. Practice makes perfect and we are all still learning.

Thanks!

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Learning Portfolios: Creative connections between formal and informal learning

Alice Cassidy, In View Education and Professional Development (alicecas@telus.net)

How do you know what students in your course 'took away' with them? Why not ask them? Through a learning portfolio assignment, I invited students to show: how they met the course objectives; connections they made to other courses as well as aspects of their lives; and their views and perspectives about the course material and processes. They were asked to include tangible evidence, examples, connections and reflections from all class sessions, discussions and other assignments. Another key criterion was that students express themselves through a creative variety of styles and formats, including a Concept Map and a world map. Students' reaction to the assignment? Many noted that it encouraged them to think critically and that it was a fun way to show links between the course and their own lives. Might you like to use or adapt some of all parts of my learning portfolio assignment in a course (any discipline) that you teach? Through reading this paper and trying the described activities, you will have completed your own mini-learning portfolio and explored methods of assessment. I will email you templates and resources for use in your own course; please email me.

"It is a miracle that curiosity survives formal education."(Albert Einstein)

Introduction

I became interested in the use of learning portfolios through several experiences related to connecting formal and informal learning. I learned many of the important skills I use today through informal, everyday practice and application (Cassidy, 2006a, 2007). Students I have interviewed feel that post-secondary institutions need to acknowledge the learning that takes place outside of credit courses (Cassidy, 2006b). I love teaching and have designed and taught both credit courses at the University of British Columbia as well as many non-credit short lecture and field-based courses that people took for the love of the topic with no grades or assignments. Hence, the mix of informal and formal learning has been very important to me both as a learner and as a teacher, and inspired me to offer these opportunities to my students as well.

In a course I taught for 14 years, I experimented with different kinds of assignments and in-class activities, sought student input through alumni advising teams and, in the last eight years of this course, assigned students a learning portfolio in lieu of a final exam. I share the templates I designed, and other aspects of this assignment with you so that you may use or adapt it for your own use.

What is a learning portfolio?

A Learning Portfolio is a collection of one's work, often customized to show evidence of meeting particular goals or to show specific areas of development, learning and growth. Learning Portfolios can be created in hard copy or electronically. Some related terms

include Course Portfolios (e.g. University of Nebraska Lincoln), Professional Portfolio (Bossers et al., 1999) and Experiential Learning Portfolio (Brown, 2002), and have been used, across disciplines, in a variety of contexts including K-12, post-secondary and professional programs.

Learning Portfolios have many valuable outcomes Herring *et al.* (2007) described how student success and motivation for learning increased through the use of standards-based digital portfolios. Brown's findings (2002) suggest that the development of a portfolio increases students' understanding of "what, why, and how they learned"; enhanced their communication and organization skills, and reinforced the importance of reflection in learning.

In my course, I introduce the Learning Portfolio assignment with this definition:

Your personal version of the course, documenting your learning throughout the term (and briefly, what you will take away with you) and presented in creative, varied, and multi-linked ways that include tangible evidence, examples, connections and reflections, based on three key criteria (coverage, links and variety of styles; Cassidy, 2008).

Overview of Learning Portfolio Use In My Course

In my course, the Learning Portfolio assignment contributed to 35% of the final grade, with one-page check-in assignment, worth 7%, handed in half-way through term to provide formative feedback, and a 10-page final Learning Portfolio, worth 28%, due on the last day of term. In-class activities provided students time on task to practise the kinds of mapping and charting expected in the Learning Portfolio.

Your Mini Learning Portfolio Assignment: Topic - Getting the most out of the next conference you attend

Part I: Setting two of your own goals/objectives

What is the next conference you are planning to attend? Think about why you registered for and are attending it. What do you hope to achieve, or get out of taking part? It costs money and your valuable time. How do you hope to make that time and money well spent, for you personally and/or professionally?

Your two goals/objectives will be the basis for your mini Learning Portfolio project. You will need one blank sheet of paper. I suggest you fold your sheet in half, lengthways, so that you have a long writing space with room for columns. Write your first Goal/Objective on the left side, in the top 'half', and other one in the lower 'half', also on the left (show example on flipchart). You will be adding more columns a few more columns. Having described this suggested format, if you prefer to go 'free-form', this can work too.

Here are a few examples that you might borrow, build upon, or be inspired by to write your own. Aim for two Goals/Objectives for now; you might have more that you can add later:

- Collect new ideas and strategies by attending sessions on topics related to my key area of practice
- Be actively engaged in teaching and learning techniques by choosing sessions that are described as such (and hope they do what they say)
- Increase my network of colleagues by meeting as many people as I can during all parts of the conference

Part II. Other sections to add

You may wish to add column for each section, or create it in more of a free-form diagram:

- Sessions to attend (sub-heading: topics, facilitators, or what institution from)
- Notes to self during unstructured time (sub-heading: receptions, breaks, banquet, other)
- My area/topics of work/study/other (optional: what you really want! e.g. attend a session just because it looks enjoyable)
- 'Wild card' - an extra section for whatever comes up. You might know what other section(s) you need, you might not know yet, or you might not need any more.

What you have just created is your own version of what I gave my students in my course. The differences are that I stated the course objectives in the syllabus, then I gave students some suggested titles for columns that I thought would help them meet the three criteria for the assignment, but of course what they chose to put in them and how they showed it is unique to them. I emailed the students a template chart that they could use as is, or adapt as they wished.

Concept Maps as a visual tool

Concept Maps are another way to organize the chart you have just started. Here are instructions on how you can try creating one, using a familiar example. You will need a blank piece of paper that we will call your 'Concept Map'. Print the key term 'house', in the middle of the map and circle it. Identify some parts of a house (examples might be room, kitchen, roof, garden, front door. Each of these is a new term that, as you add it to your map, please circle to indicate that. Add more terms if you wish. If you stopped now, many would call what you have a mind map. Now, draw an arrow between related terms, and note on that arrow what the connection is. The arrow may go one direction only, or both directions. Add more explanatory arrows as needed to describe as best you can, how all the terms you added are related. You have just drawn a simple Concept Map, showing key terms and how they are interconnected.

If you were to show the house Concept Map you just created to a colleague who did the same thing, how similar do you think they would be? Concept Maps are thought to be powerful learning tools. They closely mirror the processes of thinking and learning (Cassidy *et al.*, 2001). Because of this, it is a skill that is transferable to any situation where the creative processing of ideas is required. As you know, in any complex situation there is usually not 'one correct answer'. Hence, Concept Maps can be very unique. There are also many ways to do them, including as a flow chart from the top down, or as a tree from the roots up, or, as we did just now, starting in the centre and radiating out.

Figure 1 shows an example from my course, with permission to use granted by the student who created it. Humans are at the centre of the Concept Map, with connections, explained on the arrows, to various topics explored during the course. Some connecting topics, such as Community Service-Learning, in the bottom left, and subtopics of Biodiversity, in the top left, are then depicted using their own unique cycles of terms and arrows.

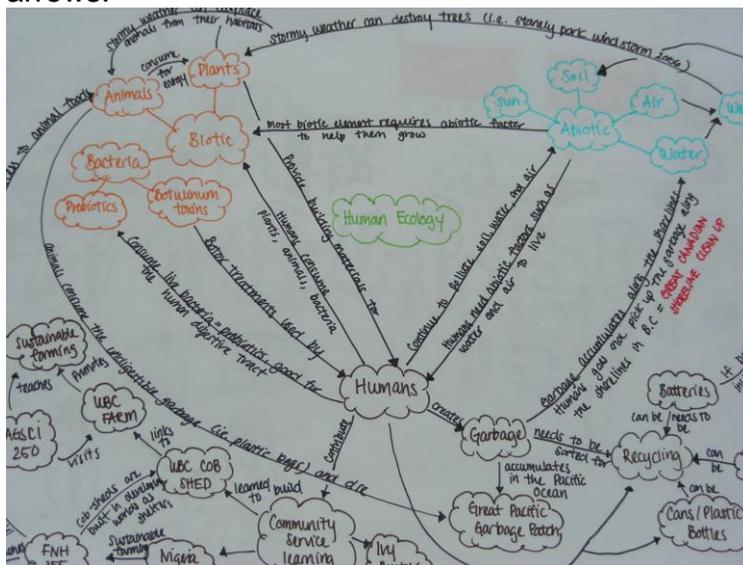


Figure 1 Example of a Concept Map.

Students created Concept Maps as part of their 10-page Learning Portfolio assignments. They also included word-image diagrams, world maps, and a variety of other methods to synthesize a large amount of material and make connections as described by the assignment criteria. **Figures 2 and 3** show two such examples, including a leaf metaphor and a Venn diagram.

which were worth approximately 33% each. I subdivided 'coverage' into columns for each of the classes' topics. As I reviewed each portfolio, I could easily check off if it was there or not (sometimes noting with an asterisk if it was done especially well), and drawing lines between cells to indicate the links students made. Through this technique, I see at a glance how well each student met the criteria for the assignment, and determine the final mark.

The mid-term check-in (one page of the Learning Portfolio) was assessed similarly, in order to give students an idea of what they were doing well and how they could improve for the final assignment. In some years, I invited students to practise self and peer-assessment during class time. This technique might work well for summative assessment in large classes.

Barrett (2007) underscores the need to pay particular attention to the difference between assessment *for* learning and assessment *of* learning. Though Concept Maps and Learning Portfolios, at a glance, may seem challenging to assess, I found that the key is to break it down into the criteria you set for your students, then methodically go through each one in turn. You may find that the 'whole is greater than the sum of the parts' and need to find a way to acknowledge extra effort or holistic value as well. Other examples of assessment techniques can be found in such works as Stoddart *et al.*, (2000) and Nicoll *et al.*, (2001).

Concluding Remarks

From eight years of inviting my students to create Learning Portfolios as a final course assignment, I found that they valued the experience very much – the creativity of it, the way it valued not only how they showed their understanding of key concepts of the course, but how it valued connections they made between the course, of formal learning, with other aspects of their lives, or informal learning. I invite you to try using this approach, and upon request by email will happily send you templates and other material I used so that you can use or adapt it for your own teaching context.

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Concept Mapping: Mirroring processes of thinking and learning

Alice Cassidy, Centre for Teaching and Academic Growth/Zoology; Tony Griffiths, Botany; Joanne Nakonechny, Science Centre for Learning and Teaching (SCLT)

Concept mapping is a diagrammatic mode of expression. It constitutes a powerful tool for use in teaching, learning and research at all levels, and we encourage you to give it a try. Explaining to students why you are using the technique and setting aside a little time for its use will rapidly move both student and teacher up the learning curve. Although concept mapping can be applied to any discipline, here we draw examples from the sciences.

Concept mapping was developed by Joseph Novak, an educational psychologist. Novak and Gowin (1984) describe the logic of concept mapping through the definition of three key terms: concept, proposition and learning.

A concept is “a perceived regularity, designated by a label.” Some examples from science would be force, methylation, recombination and cosine. The concept can be one or more words, and can be simple or complex.

A proposition (statement, assertion) is “a link between concepts.” In an example from biology, “crossing over gives rise to recombination,” the proposition “gives rise” links two concepts, crossing over and recombination. In an example from physics, “force = mass x acceleration,” the propositions “=” and “x” link three concepts: force, mass and acceleration.

The rules for propositions are that they must be concise yet as complete as possible, and understandable to another reader. When several concepts are arranged on a page linked by propositions, they constitute a concept map. Most propositions are directional, shown on the map by an arrow.

Learning is “the active construction of new propositions.” Thus, concept mapping closely mirrors the processes of thinking and learning. Because of this, it is a skill that is transferable to any situation where the creative processing of ideas is required.

We distinguish at least three types of concept maps:

1. Trees (hierarchical maps). These are arrangements of concepts in terms of some type of classification, starting at the top of the page with the broadest, and subdividing progressively down the page.
2. Webs. These are non-hierarchical arrangements in which as many interconnecting propositions as possible are shown.
3. Wheels. These maps have a central “hub” concept with propositions radiating out like spokes. Secondary rings of spokes are also possible.

Rafferty (1993) discusses the construction of concept maps, and their use in three types of learning - concept learning, representational learning and propositional learning. Broadly speaking, concept maps can be used to organize existing knowledge, or to create new knowledge. You might use concept maps to:

- help your students with personal study
- assess student performance through assignments
- assist in curriculum or course design
- organize research ideas in lab meetings, designing grant applications or outlining publications

Stoddart *et al.* (2000) developed a method to assess student learning using concept maps in combination with a rubric to extract quantitative information about the quality of understanding from each map.

According to Kinchin (2000), concept maps have been said to provide a “window into students’ minds.” That’s quite a claim, but we hope you will try out this valuable tool in communicating the structure of complex ideas as part of your teaching, learning and research activities at UBC.

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Computer software and other online links for concept mapping, mind mapping and some other visual tools:

Cmap: A free software program developed by Joseph Novak and his colleagues at the Institute for Human and Machine Cognition <http://cmap.ihmc.us/>

Concept Mapping Conference:
<http://cmc.ihmc.us/CMC%20-%20Concept%20Mapping%20Conference.html>

Concept Mapping Homepage: this unique website pays tribute to the late Jan Lanzing, who seems to have been from the University of Twente in The Netherlands. It gives some great examples and introductions to concept maps, as well as many more references and links, especially to online tools.

http://users.edte.utwente.nl/lanzing/cm_home.htm

Force field analysis: http://www.skymark.com/resources/tools/force_field_diagram.asp

Georgia Perimeter College including simple instructions on making a concept map, examples and some additional references, including web links, from other countries (some links are in German).

<http://facstaff.gpc.edu/~shale/humanities/composition/handouts/concept.html>

Graphic organizer tools from WorksheetLibrary, with some free materials and some inexpensive stuff.

<http://www.worksheetlibrary.com/subjects/graphicorganizers/charts/>

GroupMind: supporting idea generation through a collaborative mind-mapping tool. GROUP '09: Proceedings of the ACM 2009 international conference on Supporting group work.

<http://portal.acm.org/citation.cfm?id=1531674&picked=prox&CFID=1247028&CFTOKEN=19650603>

Inspiration: A software company focused mainly on K-12 students and teachers (but of interest to all educators), you can also download a free test version of Inspiration, a software to create concept maps. You will also find an interesting introduction to visual thinking and learning, some examples of concept maps, and links to other visual tools such as webs, idea maps and plots. <http://www.inspiration.com/home.cfm>

Ishikawa (fishbone) diagram <http://www.siliconfareast.com/ishikawa.htm>

Mind Manager: Another software company; check out video, demos or a 30-day free trial. <http://www.mindjet.com/>

Mind maps: are basically simpler versions of concept maps in that they do not have terms linking the key words. They are also helpful though in brainstorming and getting as many related ideas down as you can. Explore this website to see examples of how it works.

<http://mindmapper.com>

University of Sydney, Australia: Alternative Strategies for Science Teaching and Assessment, this is a big list of references, including to concept maps and graphic organizers from many parts of the world. Includes a link to VUE from Tufts University.

<http://science.uniserve.edu.au/school/support/strategy.html#Concept>

University of Tennessee at Chattanooga: this site gives an overview of concept mapping especially as it relates to curriculum design. Also includes many references on the topic, including more web links.

<http://www.utc.edu/Administration/WalkerTeachingResourceCenter/FacultyDevelopment/ConceptMapping/>

Venn diagram: http://en.wikipedia.org/wiki/Venn_Diagram

Visual Thesaurus, from ThinkMap: An interactive dictionary and thesaurus that shows connections between words in a visual display. You can try one or two words for a free trial and after that, it costs about \$3 per month or \$20 per year (US).

<http://www.visualthesaurus.com>

VisualsSpeak: Tools and resources related to graphic facilitation for professional development and other applications <http://www.visualsspeak.com/>

Vue: From Tufts University, this program has been used in curriculum design and is worth checking out (though not directly related to concept maps!) <http://vue.tufts.edu/>

Word clouds: These are a fairly recent thing that have become quite popular. You type (or copy and paste) in a set of words, and the program will display them visually, to depict the most common terms (you might use it to summarize feedback comments, for example). You can change font, layout and colour. And, the helpful FAQ at this site walks you how to take a screen shot of your wordle so that you can use it in a presentation or document.

<http://www.wordle.net/>