

Teaching, Designing, and Organizing: Concept Mapping for Librarians

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Abstract

Concept maps are graphical representations of relationships among concepts that can be an effective tool for teaching, designing, and organizing information in a variety of library settings.

Concept maps can be used wherever training or formal teaching occurs as a visual aid to explain complex ideas. They can also help learners articulate their understanding of a subject area when they create their own concept maps. When using concept mapping as a teaching tool, students may have a more meaningful learning experience when they add information to a concept map that is based on their current knowledge.

Concept maps are also an effective design tool for librarians who are planning projects. They can serve as a reference point for project implementation and evaluation, and the same is true for the design of courses, presentations, and library workshops. A concept map based on the content of a course, for example, is valuable when selecting learning outcomes and strategies for teaching and assessment.

Concept mapping can be used as a method for capturing tacit or institutional knowledge through the creation and organization of ideas and resources. Librarians can collaborate on concept maps with each other or with non-librarian colleagues to facilitate communication. Resulting maps can be published online and link to documentation and relevant resources.

This paper provides an overview of the literature related to concept mapping in libraries. Concrete applications and examples of concept mapping for teaching and learning, designing, and organizing in library settings are then elaborated. The authors draw from their own success and experience with different concept mapping methods and software programs.

Keywords

concept mapping; active learning; information organization

Introduction

Concept maps are graphical representations of relationships among concepts. Research supports the efficacy of concept mapping to facilitate knowledge acquisition, and the technique has been widely applied and evaluated in education research, the social sciences, and the natural sciences. This paper explores various applications for concept mapping in library settings based on both theory and practice, including the authors' successful use of the technique in their work. First, concept mapping can be used in teaching to explain complex ideas, help learners articulate information needs, and assess conceptual understanding. Next, it is an effective design tool for planning, implementing, and evaluating projects, courses, presentations, and workshops. Finally, concept mapping can facilitate the creation, organization, and communication of ideas and resources, particularly in collaborative settings.

About Concept Mapping

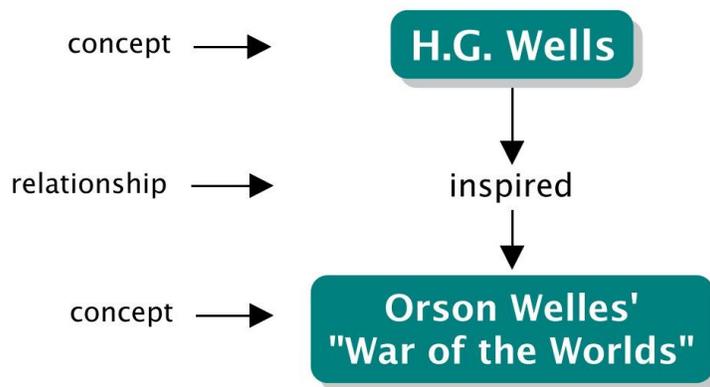
The methodology underlying concept mapping and evaluation of its efficacy have deep roots in educational psychology research. Formal concept mapping is associated with Joseph Novak and his colleagues at the Institute for Human and Machine Cognition. The technique is based on the constructivist learning theories of Jean Piaget and David Ausubel who posit that meaningful learning takes place when learners integrate new information into their existing knowledge structures (Novak and Cañas "The Origins of the Concept Mapping Tool" 176). As a learning tool, then, concept mapping makes learners' current knowledge explicit, which allows them to identify gaps in understanding and incorporate new information.

Trochim and Trochim detail how, from its roots in education, the uses of concept mapping now include facilitating knowledge acquisition, documenting and transmitting personal and shared knowledge, organizing information and tasks, collaborating, and fostering creativity. It should be noted that there are many other techniques for knowledge organization and visualization that have related purposes, all of which have different advantages for facilitating mental processes. Mind mapping and other graphic organizers, for example, usually involve creating hierarchies from a central concept. Formal concept mapping, in contrast, is meant to represent more complex types of relationships.

The basic procedure of concept mapping is to name concepts, usually represented by rectangles or circles, and then draw lines with labels that describe the relationships between the concepts (Novak and Cañas "The Origins of the Concept Mapping Tool" 177). These meaningful connections between concepts are called "propositions" (see Figure 1). Concept maps generally take a hierarchical shape, but "cross-links" that are made across the hierarchy are signs of creativity and more sophisticated understanding.

For an example of this, see the concept map "Mars: Myth and Science Fiction" (NASA). Some mappers prefer to label all concepts and then draw connections, while others create links and hierarchies as they go.

Figure 1. Sample concept map



Literature Review: Concept Mapping in Libraries

Information professionals are naturally interested in the ways in which knowledge can be organized and transmitted. Concept mapping and other techniques have been discussed amongst researchers and practitioners in a variety of library-related settings.

Librarians frequently promote visual brainstorming in their interactions with learners, and the term "concept mapping" is commonly used to encompass a variety of techniques. Numerous library web pages and handouts related to research and information literacy skills mention concept mapping, testifying to the success that many librarians have had in using visualization techniques to help learners generate keywords, select topics, and plan research projects. Beyond the simple activity of brainstorming, though, more structured approaches to formal concept mapping have also been discussed in the field.

One of the first discussions of concept mapping for librarians was Sherratt and Schlabach's 1990 article that explored the technique for assessing information studies students' understanding of reference and information services. In addition, they explored how practicing librarians can use concept mapping to organize and transmit personal and institutional knowledge related to reference services and to inform librarians' approaches to instruction and research through knowledge modeling.

In the realm of information behavior research, Gordon has investigated the relationship between concept mapping and information seeking and information literacy skills. In a doctoral dissertation and two subsequent articles, she investigated the search behaviors

of tenth-grade biology students in an American high school. In the study, she compared one group of students for whom concept mapping instruction and practice was embedded in their course with a group of students whose class did not include the technique. She found that concept mapping strengthened students' abilities in concept formation, making them more efficient and thorough in seeking information in online formats. Students who used concept mapping conducted more in-depth searches, were able to refine their searches more readily using synonyms and controlled vocabulary, and were less troubled by information overload.

In another study on information behavior, Pinto, Doucet, and Fernández-Ramos employed concept mapping to investigate the information analysis skills of library and information science students. Two groups of students in indexing and abstracting courses were presented with an article and asked to create a concept map representing the content. The researchers then analyzed the maps to compare the competencies of first and second year students. The individual students' concept maps were used to score their textual analysis abilities, such as extraction of key topics, identification of the text's structure, hierarchical ordering of concepts, labeling of relationships, and so on. The study concludes that concept maps are a useful methodological tool for evaluating students' information skills.

Structured concept mapping has also been employed by librarians in a teaching context. Tysick describes a multi-stage concept mapping exercise that librarians at the University of Buffalo use when facilitating the development of research skills among graduate students. In recognition of the limitations of teaching "generic" skills to students who have not yet explored the knowledge structures of their topic, librarians devote the majority of an information literacy instruction session to topic exploration and concept mapping. Students' maps are used to generate keywords for searching and to provide a path for their future research strategies.

Radcliff et al. likewise address the teaching angle in presenting concept mapping for assessing students' understanding of concepts related to information literacy instruction. In particular, they recommend its use as a pre- and post-test tool. Learners can create a concept map about their research process, for example, before an information literacy workshop, and then they can redraw the map afterward incorporating new information learned during the session. Radcliff et al. provide concise instructions and activities for using concept mapping in the classroom, including methods for scoring maps. While describing the effectiveness of the tool for teaching, they note that concept mapping is not often appropriate for a "one-shot" information literacy session given the time needed for students to learn the mapping technique and then actually create a map (106-114).

Examples of Concept Mapping Activities and Applications

Teaching and Learning

The use of concept mapping in teaching allows for the illustration of subject matter, promotes active and meaningful learning, and equips learners with a tool they can use throughout the research process (Novak 48-49).

When librarians are teaching complex topics, the ideas can be represented by concept maps and displayed or distributed to learners. Maps can provide a common framework for understanding and a starting point for discussion. For example, a map of the information cycle in a particular discipline, from an initial idea to published literature, provides a visual arrangement of the different formats information can take and demonstrates how they are related to each other. The University of Washington Libraries has created a scientific publication cycle concept map that has been adapted by librarians at the authors' university and elsewhere ("The Scientific Publication Cycle").

In addition, librarians who strive to include active learning exercises in their information skills sessions may find concept mapping to be effective. While learners are concept mapping, they are actively engaged in self-directed learning. If they are accustomed to rote learning and memorizing definitions, concept mapping will challenge them in new ways, as they construct their own meaning by reflecting and building on what they already know. Since the most challenging step in mapping is often labeling relationships between concepts, librarians can facilitate the mapping process by providing a list of concepts to be utilized in the map, known as a "parking lot" (Novak and Cañas "The Theory Underlying Concept Maps" n. pag.). The learners' task, then, is to arrange the concepts and articulate the connections between them.

For example, the authors have collaborated with a professor to teach concept mapping techniques to undergraduate students. As librarians, this allowed them to expand their repertoire beyond teaching bibliographic tools to include methods for learning and organizing information. The professor provided a parking lot of concepts drawn from a course reading, and the librarians introduced concept mapping techniques and provided hands-on software training. By using the parking lot, students quickly became aware of where they lacked understanding of the course reading. The technique was used later in the course for note taking and planning research strategies for term papers. The librarians also provided students with an online concept map that organized the content of the session and linked to handouts and relevant websites. Anecdotal evidence from the professor suggests that the collaborative approach to teaching this tool enhanced students' engagement in the activity, fostered a better understanding of the course readings, and aided students in structuring their final papers.

Active learning exercises may incorporate concept mapping to identify the main points of an article, to map out the steps to be followed in the research process, or to brainstorm keywords and develop a search strategy based on a topic. Concept mapping

activities can be done in pairs or small groups to offer peer-learning opportunities. Mapping can even be done with large groups if the librarian solicits ideas from students in a classroom effort to design a map. It takes time to introduce concept mapping and allow for sufficient practice, but activities can be designed for any environment: concept maps can be drawn on whiteboards or on paper, as well as with computer software (as discussed in the Concept Mapping Methods section of this paper).

The use of visual brainstorming techniques is well documented in librarians' practice, as evidenced in countless web guides and lesson plans, but more structured concept maps can also be employed. In an initiative similar to Tysick's work, one of the authors introduces concept mapping during a series of library workshops aimed at graduate students in science and engineering. The objective is for students to articulate their understanding of their research project and determine their information needs. They are first familiarized with the technique and given practice exercises before designing a concept map that is based on the question that they are trying to answer with their research. Given their investment in their research topic, they are motivated to learn and succeed when exploring the concept mapping technique. The students who participate in these workshops are encouraged to share their concept maps with their supervisors so that misconceptions in subject-based knowledge can be identified.

Ideally, advanced students who build concept maps related to their research integrate new information and revise their maps over the course of their studies. The maps also serve as guides when writing longer papers so that they can stay on track and assess their progress in seeking information. Thus, one benefit of concept mapping as a technique is that it goes beyond active learning to a more substantive, iterative learning process. The act of integrating new knowledge into the context of an existing knowledge structure represented by a concept map indeed aids in meaningful learning (Novak 48).

Designing

Learning is emphasized in the literature of concept mapping, but the technique is also effective for planning, evaluating, and creating knowledge collaboratively in library settings. For example, Nilson shows that the creative element of concept mapping lends itself well to curriculum design. Based on this insight, the authors deliver workshops for librarians to promote the use of concept mapping in designing information literacy sessions. One benefit of concept maps is that they offer a reference point for aligning learning objectives, strategies for teaching, and assessment methods. Maps can give structure to disparate levels of objectives, allowing them to be visually and conceptually tied to potential instructional methods. They also depict the course as a whole, which aids in both communication and analysis of content among librarians or professors that are team teaching or collaborating in the design. A colleague, after participating in a workshop led by the authors, now successfully uses concept mapping to facilitate the teaching of a series of workshops with a fellow librarian and one graduate student assistant. The team outlines the content of the workshops with concept maps that are later colour-coded to represent sections for which each member is responsible.

Anecdotal evidence demonstrates similarly successful applications as a result of the authors' workshops.

Likewise, concept maps can be used to design research skills instruction sessions in collaboration with non-librarians. In one successful initiative, one of the authors identifies the learning outcomes articulated in course syllabi and maps them out, connecting the objectives to the assessment used in the course. From there, library instruction methods that support the objectives are mapped and connected on the map. The librarian and the course instructor can then work through the explicit "visual landscape" of objectives to plan the specific content of research skills presentations and workshops. The process of concept mapping thus facilitates collaboration between librarians and faculty, giving them a common system for designing instruction that better supports student learning (Fitzgibbons).

This method is not limited to the design of librarian-led instruction sessions. All library services benefit from thoughtful design. Mapping activities early in the planning stages keep the focus on particular objectives rather than simply the tasks to be carried out. Concept mapping stimulates discussion as groups devoted to designing an activity or program reflect on the relationships between the concepts that represent the content. Even if each member of the team begins with a different mental image of how the library service should look, by the end of collaborative mapping exercises they may all share the same visual understanding of the design.

Concept maps are also effective tools when existing library services are re-analyzed and re-designed. The authors have been witnesses to "Aha!" moments when librarians map library sessions or programs that they had been running for several years. When connections and relationships are made visually explicit through mapping, it often becomes clear that the actions taken or strategies used were not aligned with the desired outcomes. Concept maps are thus effective as assessment and re-design tools. Similarly, if services and projects are designed with a map to begin with, the visualization provides a reference point for evaluating whether the original objectives were met or where particular areas need further development.

The map becomes a common framework for planning. It also integrates the planning and evaluation process, as the same map can represent both the goals of the project and the means by which it will be evaluated. All participants in a project can refer back to the map to check the progress in relation to the stated goals. For example, a map of a complex library de-selection project makes visually clear which person is responsible for particular tasks and how the tasks relate to each other. Staff members who are overseeing parts of the project can create their own maps, but then all are brought back to a master plan, making sure that the parts are conceptually connected and cohesive.

Organizing

Concept mapping is fundamentally a tool for organizing knowledge, and in library settings, it has applications for individuals and groups alike. Concept maps can assist

librarians in various aspects of their job as a means of organizing their ideas and making tacit or "instinctual" knowledge explicit and external. The meta-cognitive act of recording knowledge about a particular subject in a concept map allows mappers to articulate their understanding of concepts and allows for the reflection on where this knowledge can be applied.

In collaboration with a colleague, one of the authors created a concept map to organize their collective knowledge on surveys, from the planning stage to design and administration (Colosimo). The mapping process necessitated clarification from the literature on matters of survey design and prompted the exploration of data analysis resources that could be added to the map. It also clarified where mistakes had been made with library surveys administered in the past. The concept map was later shared with librarians in a professional development workshop.

In workplace settings, moreover, concept mapping can be effective for capturing, transmitting, and preserving institutional knowledge. For example, library workers who are experts on particular procedures in collection development or in other areas can map out their knowledge before leaving the organization or when training new employees to transmit information that would otherwise be lost.

Concept maps are also effective for collaboratively organizing team projects, as they can provide a common visual landscape and shared vocabulary from which different individuals can work. Maps make the connections between concepts explicit, allowing information to be transmitted from one person to another in a mixed format that incorporates both verbal and extra-verbal (i.e., visual) social group behaviors (Trochim and Trochim vii). All participants in a project can actively engage in mapping, prompting discussion and participatory decision-making. For example, the Claremont College Library has used concept mapping to organize and document service initiatives and future plans, capitalizing on the dynamic capabilities of concept mapping software to capture collaborative discussion (Booth n. pag.).

One key benefit to using a concept map to organize a project is the compactness of representation (Novak and Cañas "The Theory Underlying Concept Maps" n. pag). As a supplement to lengthy written documents, maps can provide the full picture at a glance. The representation increases participants' ability to process complex problems and bodies of knowledge when it is externalized in a visual format. In this way, a map can help project planners and participants see where more information is needed and identify potential problems. It can also facilitate time management when tasks and time frames are aligned visually.

In addition to organizing knowledge and concepts, digital concept maps are effective for organizing documents and online resources. Linking functions are common in many software programs. In all of the examples discussed here, the authors used a concept mapping program to organize handouts, websites, videos, presentation slides, and so on for teaching and working on group projects. When maps and files are saved on

shared servers, collaborators can refer to information contained in the maps at the same time as accessing relevant resources (see Figure 2).

Figure 2. Concept map for organizing resources

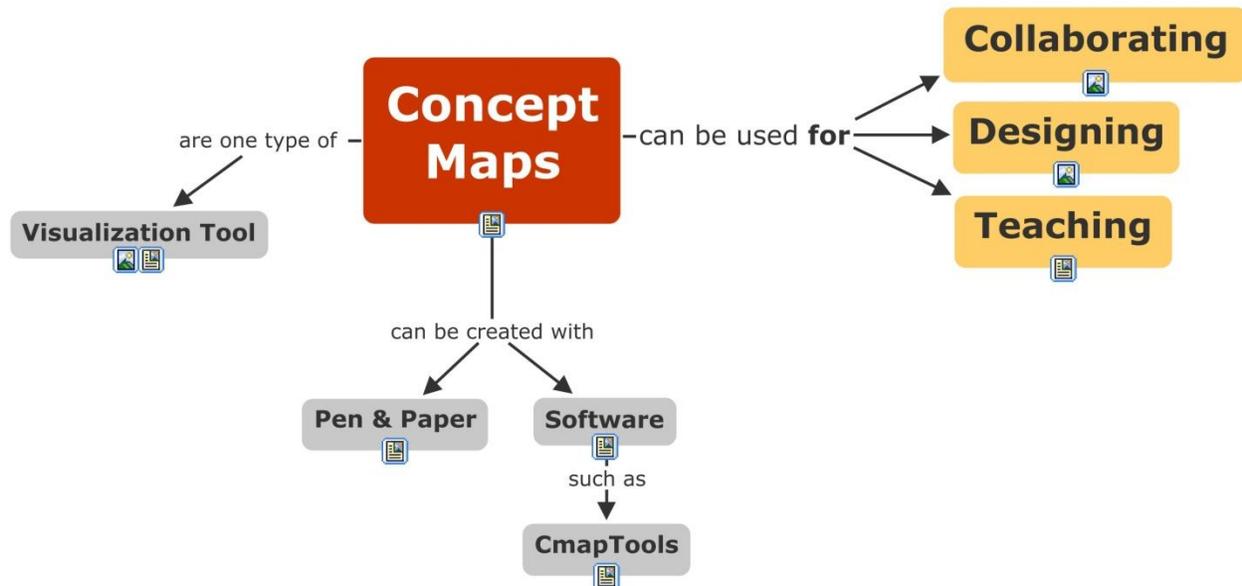


Figure 2 is an example of a map used to organize files for a workshop. The icons on each concept represent attached files and links (Colosimo and Fitzgibbons).

Concept Mapping Methods

For all of these uses of concept mapping, whether undertaken individually or collaboratively, maps can be drawn by hand or created with computer software.

The authors have had success in teaching concept mapping by using an exercise that begins the mapping process with sticky notes (see Appendix for an example). Participants are first prompted to write a few sentences about the topic they want to map (e.g., a theoretical subject, a project to design, or a course plan to organize). Next, the key concepts are identified in the text and written on separate sticky notes. Participants then begin to arrange the concepts according to their connections to each other, with the relationships labeled. With sticky notes, the concepts can be easily arranged and rearranged on a sheet of paper, the inside of a folder, or even a wall.

Some learners find additional motivation and inspiration for concept mapping when they use software. To this end, the authors have employed the program CmapTools for

teaching and designing concept maps in a variety of contexts. In addition to being easy to learn, one of CmapTools' strengths is the depth of research that underlies its creation as well as the extensive documentation provided. Compatible with Windows, Macintosh, Linux, and Solaris, the program is free to download and distribute.

CmapTools has capabilities for attaching and linking to any type of file, and maps can be exported in several formats including web pages, images, and PDFs. Other useful features include internal video recording of map creation, a presentation builder, and a text-to-map function. Maps created with CmapTools can be saved on private or public servers, with customizable editing and viewing permissions. The software thus enables synchronous and asynchronous collaboration, as multiple users can edit maps saved on shared servers. Users can upload maps to Cmappers.net, a searchable collection of concept maps and other resources related to the software.

The authors have also used a fee-based program called Inspiration, which has a web version as well (Webspiration). In comparison with CmapTools, Inspiration lends itself to more free-form maps and formatting options but lacks some of the linking, sharing, and exporting functions. Other commonly-used programs include Mindomo, VUE, Xmind, and Popplet. Popplet in particular is also gaining popularity as an application for Apple mobile devices.

Concept mapping software allows for rapid generation of concept maps, aids in creating sophisticated formatting and visual styles, and enables the use of many media types. However, some feel that the constraints of the software limit creativity. It is suggested, then, that mappers experiment with multiple methods in tandem. When working with a software program, the use of a tablet and stylus instead of a mouse and keyboard can mimic the kinesthetic creativity of pen-and-paper drawing.

Some would-be mappers are anxious to know whether their concept maps are "good." It is important to remember that there is no single "correct" way to create a concept map. Although it is true that relationships can be labeled incorrectly when working with objective knowledge, there is always more than one way to illustrate connections between concepts. When mapping is used for personal knowledge exploration, the most important thing is that mappers reflect on the meaning that is created amongst the concepts, returning to the map frequently to incorporate new knowledge. Even in collaborative settings, the shared understanding that results from the process of creating the map is what is important, more than the shape of the map itself. Moreover, concept maps are never complete; they are always works in progress as new meanings and connections emerge in the body of knowledge represented.

Conclusion

The authors have given a number of workshops and conference presentations on concept mapping aimed at librarians as well as educators, students, administrators, and IT professionals.¹ The sessions have been well-received, with participants later sharing the multiple ways in which they have used concept mapping in their own work to plan projects, teach, or organize information. Events like a university's teaching with technology forum, for example, are excellent venues for librarians to promote new uses of technology, such as concept mapping software. Indeed, librarians can take on new roles by offering training and raising awareness about concept mapping techniques, going deeper in their support of teaching and methods of organizing information.

Overall, concept mapping facilitates cognitive processes. The activity of concept mapping allows the vastly complex human mind to externalize unconscious processes and examine relationships. One key benefit of concept maps is their visual compactness, which allows complex bodies of information to be represented in a single object. Maps increase individuals' working memory and their ability to process complex problems by externalizing information (Novak and Cañas "The Theory Underlying Concept Maps" n. pag.). Further, visualizations can serve as templates or scaffolds to provide structure to knowledge.

In the realm of teaching and learning, for example, concept mapping facilitates meaningful learning and active engagement in knowledge acquisition. Librarians can use concept mapping to introduce complex ideas, to help students articulate their information needs, and to assess student understanding and detect misconceptions. Concept maps are also highly effective design tools. Librarians can use concept mapping to design courses and information skills sessions, to plan projects and services, and to evaluate initiatives. Finally, concept maps can be used to organize personal and institutional knowledge, provide structure to collaborative activities, and organize electronic documents and resources. The activity of concept mapping can be undertaken individually or collaboratively, and maps themselves can become powerful communication tools.

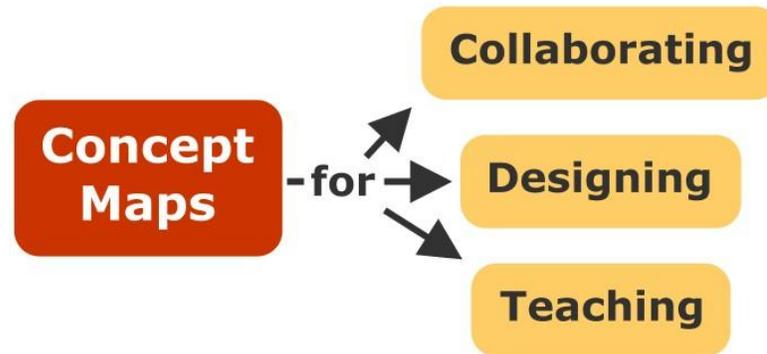
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Appendix: Concept mapping workshop handout



Concept Maps for Collaborating, Designing, and Teaching

April Colosimo and Megan Fitzgibbons

Pen and paper exercise

Choose an area of interest to your professional work (5 min):

Please select **one** of these possible uses of concept mapping and answer the question below.

Collaborating on projects:

You may be leading or collaborating on a project. What is the goal of the project and what are the tasks involved?

Designing a workshop or a readers' advisory tool:

Think about a workshop or readers' advisory tool that you would like to (re)design. What is the focus of the workshop/tool?

Teaching a complex subject or process:

Think about a particular subject or process you will be teaching. How would you describe the main ideas in a few sentences?

Create a concept map related to your professional work (15 min):

1. Circle the main concepts/ideas from the above description.
2. Write each concept on a separate sticky note.
3. Think about a way to arrange these concepts: are some related to others? Is there a sequence? Is there a visual representation that would capture the relationship between these concepts/ideas?
4. Arrange the sticky notes in a visual representation that captures the relationships between the concepts. It helps to label the connections!

Exchange feedback (10 min):

Pair with another participant and exchange feedback about your concept maps. See below for suggested ways to critique a concept map:

Suggested Ways to Critique a Concept Map

Ask the following questions:

1. Are any concepts stated verbally that are not included in the map?
2. What is the specific relationship between/among each of the concepts?
3. Is it easily apparent which concepts are central/important?
4. Is it easily apparent which concepts are peripheral/less important?
5. Have any relationships been overlooked?
6. What would happen if concept "x" were moved?

Integrate feedback (5 min):

Briefly revise your concept map, integrating the feedback received.

Note: There are also free software options out there, such as CmapTools, (cmap.ihmc.us/conceptmap.html), for presenting and collaborating on concept maps.

Adapted from: wikisites.mcgill.ca/cdi/index.php/Mapping_course_content