



## Module 5- Exploring for Learning

### Required Readings

The following two readings have been included in this module to provide you with further information on how graphic organizers, in particular mind maps and concept maps, are being used in higher education. You will also find many useful resources on graphic organizers listed in the suggested reading and module references sections provided as part of the module learning tools.

1. Show Them the Money: Using Mind Mapping in the Introductory Finance Course by Ernest N. Biktimirov, Brock University and Linda B. Nilson, Clemson University\* 2
2. Using Concept Maps with Adult Students in Higher Education by Barbara J. Daley, University of Wisconsin – Milwaukee 26



**Show Them the Money:  
Using Mind Mapping in the Introductory Finance Course**

Ernest N. Biktimirov\*  
Faculty of Business  
Brock University  
500 Glenridge Ave  
St. Catharines, Ontario, Canada L2S 3A1  
905.688.5550 x 3843  
ebiktimirov@brocku.ca

Linda B. Nilson  
Office of Teaching Effectiveness and Innovation  
Clemson University  
445 Brackett Hall  
Clemson, SC 29634  
864.656.4542  
nilson@clemson.edu

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\* Contact author



## **Show Them the Money:**

### **Using Mind Mapping in the Introductory Finance Course**

#### ABSTRACT

In this paper, we offer an innovative teaching tool for finance instruction, mind mapping, which visually depicts concepts and their interrelationships in a non-linear way. We review the considerable literature on the pedagogical benefits of graphics, describe how to design a mind map, recommend how to introduce students to mind mapping, and present examples of mind maps for introductory finance. The appendix provides information on commercial mind mapping software.

#### INTRODUCTION

When we teach finance, we want to inspire students' interest in the world of finance, show them the “big picture” of how concepts interrelate, and make their learning easier and more efficient. We work to develop their problem-solving and decision-making skills and encourage their taking creative approaches to problems. And we need all the help we can get, especially in introductory finance. This course attracts students of widely differing backgrounds, motivations, and learning styles, and most of them come in with little understanding of or interest in finance. They also find the subject very difficult, both before and after the course [Krishnan, Bathala, Bhattacharya, and Ritchey, 1999].

In this paper, we propose a teaching tool that can help us overcome these learning barriers and meet our instructional goals: mind mapping. Our endorsement of this tool is based on two bodies of research: one that documents the teaching effectiveness of mind mapping in



specific disciplines and the other that gives strong evidence of its general learning benefits. Both are reviewed in the next section.

Mind maps are visual, non-linear representations of ideas and their relationships. An example of one is Figure 1, which graphically summarizes the organization and content of this paper. By using colors, images, and key words, mind maps engage both sides of human brain and increase its learning potential. Unlike some visual tools, they can easily be posted online with hyperlinks to the wealth of finance-related information on the Internet.

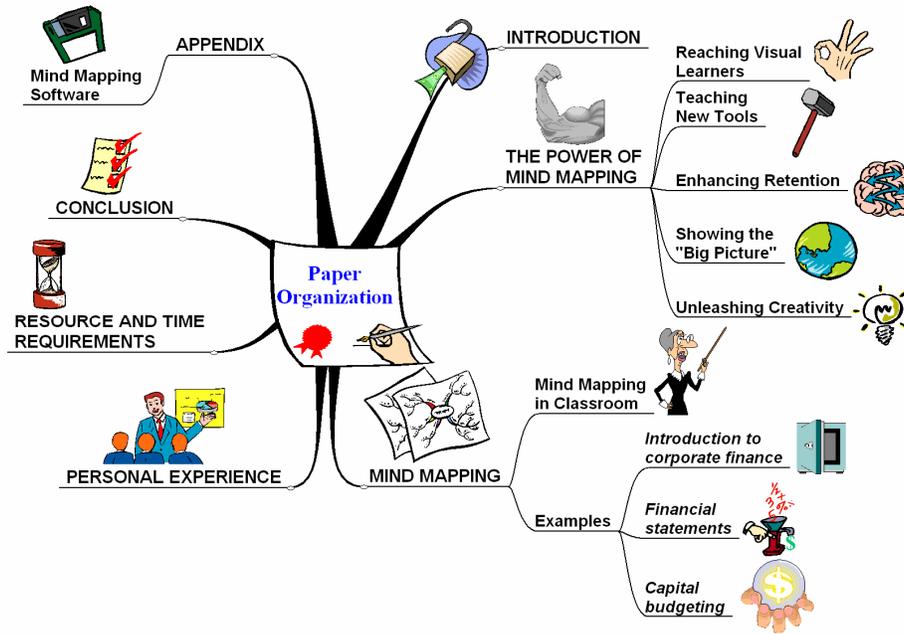
Our intention here is to acquaint readers with mind mapping, review the research about its pedagogical value, and demonstrate how it can be used to teach finance. Our examples come from introductory finance because students benefit the most from mind mapping if they start using it early in their college careers, when they have little background in the subject matter [Mayer and Gallini, 1990]. But as the research shows, graphics enhance learning at all levels.

#### THE RESEARCH ON THE POWER OF MIND MAPPING

Instructors have found mind maps to be successful teaching aids in economics [Nettleship, 1992], marketing [Eriksson and Hauer, 2004], executive education [Mento, Martinelli, and Jones, 1999], and optometry [McClain, 1987]. Concept maps, a related teaching tool, have similarly proven highly effective in teaching accounting [Leauby and Brazina, 1998], applied statistics [Schau and Mattern, 1997], college-level reading comprehension [Mealy and Nist, 1989], biology [Kinchin, 2000, 2001], nursing [Baugh and Mellott, 1998; King and Shell, 2002; Schuster, 2000; Wilkes, Looper, Lewin, and Batts, 1999], and medicine [Hoffman, Trott, and Neely, 2002; McGaghie, McCrimmon, Mitchell, Thompson, and Ravitch 2000; West, Pomeroy, and Park, 2000], among other fields.



FIGURE 1. Mind Map of the Organization of the Paper





Concept maps differ from mind maps in a number of ways. They are structured like a network in which any concept or idea can be connected to any other, while mind maps follow a tree structure that clearly distinguishes among primary, secondary, and tertiary ideas. In addition, mind maps use colors, images, line thickness, etc. to communicate meaning, while concept maps do not.

Despite extensive use of visual tools in different disciplines, their use in finance has been very limited beyond graphs, pie charts, and bar diagrams. The graphic syllabus [Biktimirov and Nilson, 2003] provides a rare example of the broader use of visual tools in introductory finance.

In fact, several major literature reviews amass abundant, convincing evidence that visual displays in general enhance learning [e.g., Vekiri, 2002; Winn, 1991]. Here we summarize how their benefits accrue.

#### Reaching Visual Learners

Since students' learning style preferences affect their performance in introductory finance courses [Filbeck and Smith, 1996], instructors should use diverse teaching and assessment strategies to help all students learn and achieve academically. By showing how concepts and processes interrelate in terms of spatial relationships, images, colors, and codes, mind mapping helps instructors reach their visual, global, and concrete learners, who tend to think in sensate and spatial terms [Clark and Paivio, 1991; Svinicki, 2004; Theall, 1997]. Such visual aids encourage these learners to process knowledge at a deep rather than a surface level [Svinicki, 2004]. According to the visual argument theory, graphics are effective because they communicate information through both individual elements and their arrangement in space [Larkin and Simon, 1987; Waller, 1981].



### Teaching New Tools

As instructors, we strive to teach students not only our subject but also efficient methods for learning it, both in our courses and after graduation, and mind mapping is a demonstrated life-long learning tool. First developed for note-taking, it has proven useful in many other cognitive activities that involve memory, planning, organizing, and creating, such as outlining papers and oral presentations, problem solving, organizing and summarizing material for tests, and even creative writing [Buzan, 1974, Svinicki, 2004]. Mind mapping also has many business-related applications worth teaching our students, such as project management, preparing “to do” lists, and managing meetings [Wycoff, 1991].

### Enhancing Retention

Whichever leading theory one considers, well-constructed mind maps are almost impossible to forget. In support of the dual coding theory, research findings in neuroscience and cognitive psychology indicate that people process and store verbal and visual-spatial information in separate cognitive systems, often called the semantic and episodic memories, respectively. This literature also suggests that graphics, such as a mind map of text material, facilitate learning by enabling student to store knowledge in both systems, and not just in the typical linguistic form. Material received in both verbal and visual modalities tends to be retained better and longer than that received in only one form, and it can be accessed and retrieved more easily via two paths than it can via one [Paivio, 1971, 1990; Svinicki, 2004; Vekiri, 2002].

The visual argument theory mentioned above also posits that graphics such as mind maps make material more memorable but for a different reason: because they convey information more efficiently than text, through both their individual elements and the spatial arrangement of



those elements. Specifically, they require less working memory and fewer cognitive transformations.

The effect of mind mapping in particular was recently tested by Farrand, Hussain, and Hennessy [2002] on 50 second- and third-year medical students. These researchers found that using mind mapping as a study method improved the students' factual recall of text one week after reading it.

#### Showing the “Big Picture” of Key Material

Students frequently view new concepts as isolated and independent and have difficulty understanding how they relate to each other and to previously learned material. Mind mapping prevents this problem by clearly laying out the key concepts and dimensions and the relationships among them in one “big picture” image, enabling students to see what material is most important and how the various pieces fit together. It accommodates even complex, non-linear relationships and cross-references. In fact, graphics in general facilitate the process of inferring relationships more so than text does [Robinson and Kiewra, 1995; Winn, 1991]. Mind mapping also makes the organization of the knowledge explicit, providing students with an accurate, ready-made structure for making sense of the knowledge and storing it. Without a structure, knowledge degenerates into irrelevant and utterly forgettable factoids [Svinicki, 2004].

#### Unleashing Creativity

Given the importance of creativity for the success of organizations [Mumford, 2000], we need to foster it in our courses [Driver, 2001; Hanlon and Figler, 2002]. This is especially true in finance since the field is perceived as so structured and factual that creative students shy away from it as a career [Chan and Shum, 2003]. Mind mapping can transform this dry, staid image.



Sometimes referred to as “brainstorming on paper,” it encourages creativity by engaging both the analytical and holistic sides of the brain, liberating it from linear thinking and releasing the flow of new ideas.

#### MIND MAPPING IN THE CLASSROOM

Buzan [1974] developed the standard mind-mapping techniques and guidelines that we summarize here. A mind map locates the main concept in the center of a page with related ideas radiating out in various directions. All the words that appear should be *key* words (nouns or verbs) that represent the briefest, sharpest way to capture the idea. Supporting concepts may radiate from the secondary ones. Lines connect the concepts, with central lines being thicker than supporting ones. Use of color, images, symbols, and shorthand codes should elaborate or reinforce the concepts and the relationships among them.

These guidelines aside, mind mapping is pretty intuitive. Once students see a mind map, they know how to design one. So we suggest introducing students to mind mapping by showing them a completed, finance-related map and reviewing the basic principles of creating one. Then students can start designing one themselves – perhaps first as a whole class, then in small groups – for a key finance concept or topic or a textbook chapter. On this first try, students will benefit from instructor feedback and the chance to revise their maps. From then on, students can create mind maps on their own. These graphics make excellent homework assignments and in-class group activities. As they force students to select key material, interrelate it, and summarize it, they can also serve well as test preparation exercises. For the same reasons, they can be test questions. Having students show their understanding in a mind map rather than an essay is not



only more creative but also easier to grade. Instructors can adapt Wallace and Mintzes' [1990] scoring system for grading concept maps to grading mind maps.

#### Examples of Using Mind Mapping

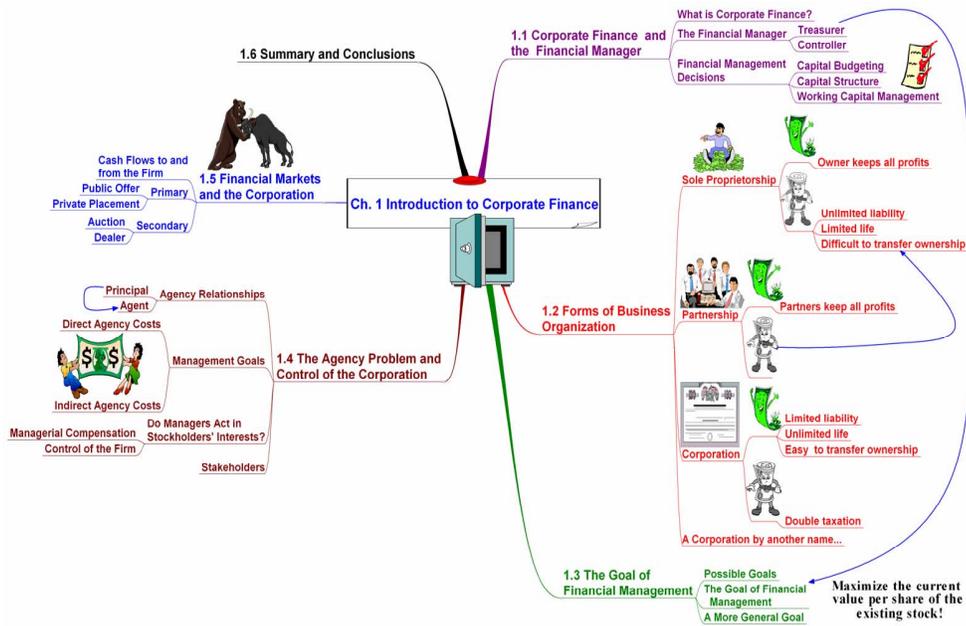
The examples of mind maps shown here are based on the popular corporate finance textbook by Ross, Westerfield, and Jordan [2003] and are produced using the software MindManager 2002 Business Edition. (See Appendix for more software options.)

#### *Introduction to Corporate Finance*

Figure 2 is a mind map of the first chapter of Ross et al. [2003], an introduction to corporate finance. It has one major branch for each of the six sections of the chapter with concept-appropriate images added to activate students' visual attention and memory. For example, the central icon is a safe with an open door to represent the students' entrée into the world of finance. A single man sitting on a pile of cash represents the sole proprietorship form of business organization (owned by one person who keeps all the profits). Similarly, a group of men gathered around a computer illustrates the partnership, and a stock certificate, the corporation. A happy dollar and a dollar tightening its belt cue the advantages and disadvantages of each form of business organization. A double-arrow line between the disadvantages of the sole proprietorship and the partnership reinforces the fact that both forms have basically the same drawbacks. Other images reinforce other points in the chapter. For instance, the cartoon of a man and a woman pulling a dollar bill in opposite directions next to the management goals topic depicts possible conflicts of interest between the stockholders and management of a firm. The picture of the bull and the bear pushing against each other symbolizes the bull and bear markets.



FIGURE 2. Mind Map of “Introduction to Corporate Finance” Chapter





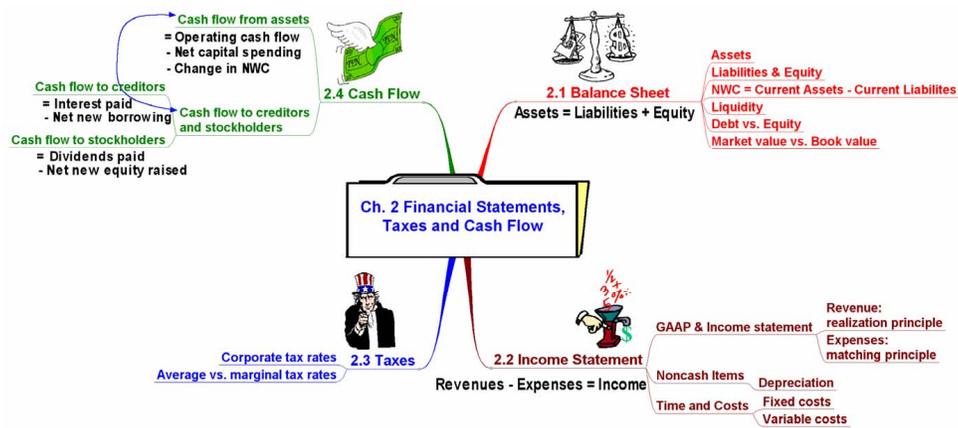
One of the authors has posted this mind map on the web for his introductory finance students at <http://www.brocku.ca/mindmapping>. It is broken into sections and contains hyperlinks to additional information on every branch. For example, when students click on “Auction” in the “1.5 Financial Markets and the Corporation” branch, they go to a page with a brief description of auction markets and links to major exchanges. Other links access definitions, examples, equations, information on related concepts and principles, summaries and conclusions, and self-study questions. The students have consistently said that they enjoy using mind maps, find them very helpful for learning the material, and plan to create them in other courses.

*Financial Statements, Taxes, and Cash Flow*

Figure 3, our next example, maps out chapter 2 of Ross et al., 2003, which is on financial statements, taxes, and cash flow. Again, icons communicate the key concepts. A scale conveys that the balance sheet has to balance, and a mincer converting numbers into a dollar sign symbolizes that an income statement uses all revenues and expenses to produce the bottom number – net income. The double arrow in the upper left corner shows the equality between cash flow from assets and cash flow to creditors and stockholders. Like the mind map of chapter 1, the one of chapter 2 has an Internet version with incorporated hyperlinks to supporting material. It is also available at <http://www.brocku.ca/mindmapping>.



Figure 3. Mind Map of “Financial Statements, Taxes and Cash Flow” Chapter





*Capital Budgeting*

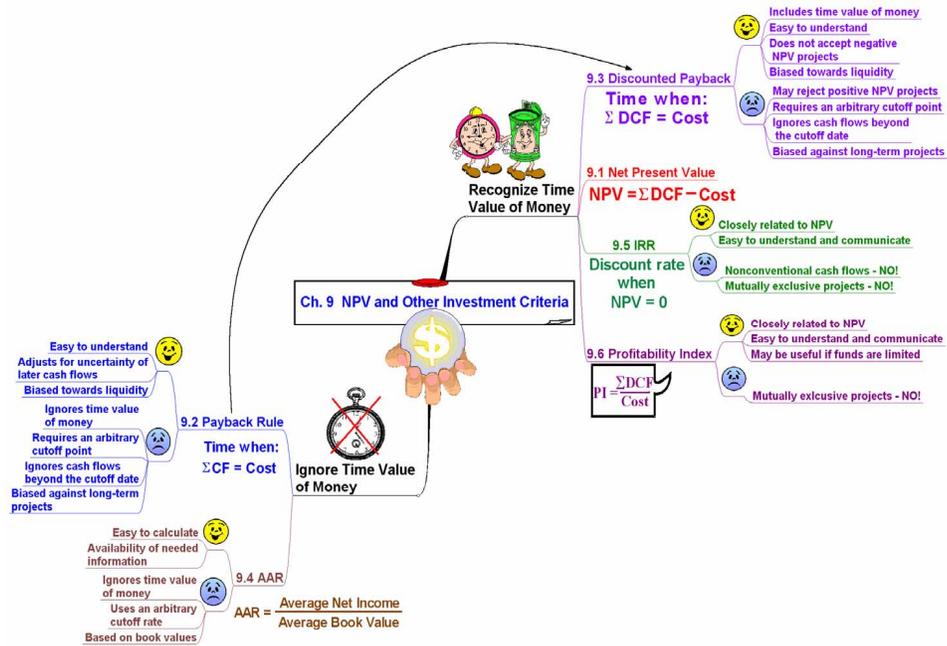
Our final example, Figure 4, graphically shows the organization and main points of Ross et al.'s [2003] chapter 9 on capital budgeting techniques. On just one page, the mind map displays all the material in the chapter and its interconnections, thus facilitating association and integration. To help students see how the graphic mirrors the chapter, the map uses the same section numbers and titles as the textbook.

Many students find the conceptual density of this chapter, which presents six capital budgeting techniques, overwhelming. The mind map helps them organize and “chunk” this material by categorizing the techniques according to a crucial distinction: whether or not they take into account the time value of money. The spatial distance between the two groups reinforces this difference. The map also makes obvious a key relationship between the groups – how the Discounted Payback extends the ordinary Payback Rule – by linking them with an arrow. With each method is its corresponding formula, so students can use the mind map as a reference.

Associating key words with complementary images wherever possible facilitates dual-coding and adds eye appeal, and Figure 4 shows many examples. In the center of the mind map just below the chapter title is a crystal ball with a dollar sign, which associates the idea of investment criteria with the prediction about the profitability of future projects. Just above are a smiling clock and a dollar bill holding hands, suggesting a time-money connection, located right next to the four capital budgeting techniques that recognize the time value of money. To designate the opposing group of techniques is a crossed-out clock. The happy and sad faces imply the advantages and disadvantages of each method.



FIGURE 4. Mind Map of “NPV and Other Investment Criteria” Chapter





#### PERSONAL EXPERIENCE WITH MIND MAPPING

To add to the evidence in the literature of the educational benefits of mind mapping is the informal student feedback one of the authors has been receiving in his courses. Specifically, his students have frequently mentioned that studying with mind maps has helped them to understand the material — in particular, conceptual interrelationships — as well as to review for tests later in the course. They have been particularly appreciative of the mind map for the challenging textbook chapter on capital budgeting techniques. Its most helpful feature, they have said, is its concise, one-page organization of all the important material in the chapter. Moreover, some students have volunteered that they have extended their use of mind maps to other courses.

Colleagues have also reacted positively to the idea of teaching with mind maps. On his colleagues' request, the same author has conducted annual mind mapping workshops for both undergraduate and graduate students for the past six years. In addition, he has led numerous mind mapping workshops at his home institution and across Canada for faculty in various disciplines. The other author has also facilitated over a dozen faculty and graduate student workshops on mind mapping and other similar graphical teaching tools at her own university and at conferences in the U.S., Canada, and Australia. In both authors' experience, workshop participants have given mind mapping and similar visual tools an enthusiastic reception, and many have incorporated them into their courses.

#### RESOURCE AND TIME REQUIREMENTS

Developing a mind map, whether as a Word document, a PowerPoint slide, or a web page, is not technologically difficult or expensive. Instructors can develop professional-looking



mind maps on any standard desktop or portable computer using one of many moderately-priced mind mapping programs (software details in Appendix).

How much time and effort the development process takes will vary from instructor to instructor. Creating a mind map for a major topic or a textbook chapter, for example, will take from 15 minutes to two hours depending upon one's familiarity with the textbook, one's facility with the software, and the complexity of the material. The online version of the mind maps for chapters 1 and 2 of Ross et al. [2003] (Figures 2 and 3 in this article, online at <http://www.brocku.ca/mindmapping>) incorporate at least one additional layer of web pages with definitions, examples, equations, information on related concepts and principles, summaries, and conclusions. Developing all these supporting web pages with text, images, and links can require up to 35 hours for one chapter.

#### CONCLUSION

We recommend mind mapping to help students learn finance, especially at the introductory level, with a vast amount of research behind us. Compared to text, visual displays like mind maps are more effective for many purposes: conveying knowledge to students with visual/global/concrete learning styles; facilitating a wide range of academic and management tasks; facilitating the cognitive processing and retention of material; communicating “the big picture” and the interrelationships among its elements; and fostering creative thinking. With graphics as teaching and learning aids, students need not experience finance as a difficult, dull, mechanical subject, and instructors need not sacrifice content to shuttle them through courses. In addition, mind mapping is easy. After an example, some guidelines, and some instructor feedback on first attempts, students can do it on their own.



Visual displays of course materials – such as the topical organization of the course, textbook chapters, and key concepts and processes – are likely to become more important and even expected components of courses, especially as distance education and computer-assisted classroom instruction grow more commonplace [Cyr, 1997]. Web-based and video technologies invite graphics, and today’s students seem to be better adapted to them than to text. But their value doesn’t rest on modern technology. Hasn’t a picture always been worth a thousand words?

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## APPENDIX

### Mind Mapping Software

Table 1 displays basic information obtained from online sources on a sample of commercial mind mapping programs. Instructors can choose from a considerable variety of products at affordable prices, and all but three companies (Inspiration Software, Inc., Gael Ltd., and Mind Technologies AS) offer educational discounts. Even the exceptions take educational budgets into account. Inspiration Software's products are designed for educators and are priced accordingly. Gael Ltd. offers an indirect discount by marketing a less expensive educational version, MindGenius Education 2005, which has the same functionality as a full-priced business version, MindGenius Business 2005. While Mind Technologies does not give an educational discount on its main program, it offers a lower-cost, cut-down version, Visual Mind Basic Edition.

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Insert Table 1 about here

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All the companies offer multiple versions of their mind mapping software, which differ primarily in price and the number of features, except CoCo Systems Ltd., which sells only one version of its software (VisiMap Professional). In addition, all the companies offer a free trial download, giving potential users the opportunity to test the programs. Some of them also offer quantity discounts and network licensing deals to make course and school-wide purchases more affordable.



All the programs can export finished maps onto web pages and can incorporate hyperlinks, allowing instructors to take advantage of the vast amount of finance-related material on the web. The export options allow the user to save a final map in various formats and to send it to others to view and print, even those who do not have the mind mapping software in which it was created. With almost all the software integrated with Microsoft Office, mind maps are easily exported into Microsoft Word, PowerPoint, Project, and Outlook. Many companies offer not only different export options but also free, downloadable viewer programs that let users without mind mapping software open, view, and print the mind maps.

While all the programs function in the Windows operating system, ConceptDraw MINDMAP, Inspiration, and MindManager work with Macintosh as well. Several companies also offer special versions of their mind mapping software for Tablet PCs (for example, MindGenius Brainbloom) and for handheld computers (for example, MindMapper PDA)

With all the programs, instructors can set off and differentiate among concepts with colors, shapes, patterns, shadows, fonts, and styles. They can also draw from vast collections of symbols or import images in different formats to visually depict and/or draw attention to certain ideas. Inspiration and MindMapper can even incorporate sound files. This feature allows instructors to create a mind map with a talking interface, which is a great help to auditory and visually challenged learners. In addition, some of the programs are available not only in English but in other languages as well.

Even a novice user of graphics software can quickly acquire a basic proficiency in the programs listed in Table 1. They usually come with pre-installed tutorials, sample mind maps, and templates, making them relatively easy to learn and to use.



TABLE 1. Mind Mapping Programs (as of October 2005)

Product	Price/ Educational Discount	Free Trial/ Viewer	Operating Systems	Other Versions	Company Information	
					Name	Telephone/Internet
ConceptDraw MINDMAP Standard 4.0	\$99/Yes	Yes/Yes	Windows; Macintosh	Professional	Computer Systems Odessa, Corp.	Not Available www.conceptdraw.com
Inspiration 7.6	\$69/No	Yes/No	Windows; Macintosh	Kidspiration 2.1; Inspiration for Palm OS; Inspiration for Pocket PC	Inspiration Software, Inc.	1-800-877-4292 www.inspiration.com
MindGenius Business 2005	\$247/No	Yes/Yes	Windows	Education 2005; Home; Brainbloom	Gael Ltd.	+44 (0) 1355-247766 www.mindgenius.com
MindManager Basic 6	\$229/Yes	Yes/Yes	Windows; Macintosh	Pro 6; 6 Mac	Mindjet	1-877-646-3538 www.mindjet.com
MindMapper Professional 4.5	\$179.95/Yes	Yes/Yes	Windows	Academic 4.5; Junior; PDA 1.0 Palm	SimTech Systems, Inc.	425-445-2514 www.mindmapper.com
VisiMap Professional 4.0	\$132.30/Yes	Yes/Yes	Windows	Not Available	CoCo Systems Ltd.	+44 1952-676696 www.visimap.com
Visual Mind Business Edition 7	\$199/No	Yes/No	Windows	Basic Edition	Mind Technologies AS	+47 3285 5455 www.visual-mind.com



Concept Maps: Theory, Methodology, Technology  
Proc. of the First Int. Conference on Concept Mapping  
A. J. Cañas, J. D. Novak, F. M. González, Eds.  
Pamplona, Spain 2004

## USING CONCEPT MAPS WITH ADULT STUDENTS IN HIGHER EDUCATION

*Barbara J. Daley, University of Wisconsin – Milwaukee  
Email: bdaley@uwm.edu www.uwm.edu/~bdaley*

**Abstract:** The purpose of this study was to investigate the ways in which the use of concept maps influenced the learning processes of adult graduate students in the context of higher education. Two groups of students were taught to use concept mapping as a constructivist learning strategy and then were followed over the course of a year to determine the impact this strategy had on their learning. Results indicate that adult graduate students became more aware of their own learning processes, changed their learning strategies and articulated changes in their thinking. Implications for teaching and learning in higher education are drawn.

### 1 Introduction and Problem Statement

Adult graduate students often enter higher education programs relying on learning strategies that have worked well for them in the past (Merriam & Caffarella, 1999). These previous learning strategies often include rote learning, passive learning, memorization and recall of facts. Assisting adult graduate students to broaden their learning strategies is a major factor contributing to their academic success in higher education (Gibbons, 1990; Novak, 1990; Smith, 1982) and to their ability to function in the workplace. The purpose of this study was to assist adult students to enhance their learning through the application of teaching strategies that foster a constructivist approach to learning.

### 2 Conceptual Framework

Merriam and Caffarella (1999) define five different learning orientations including: behavioral, social, humanistic, cognitive and constructivist learning. They believe that within each of these learning orientations different assumptions exist about the nature of learning and the strategies that instructors can use to facilitate learning. Since the purpose of this study was to assist adult students to broaden their learning strategies, the constructivist learning orientation provided the overall conceptual framework for this study.

Constructivist learning has evolved to include multiple approaches and perspectives. For the purpose of this study, constructivist learning is seen as a cognitive approach that locates cognition and understanding within the individual. The most salient feature of this perspective is the “notion that learners respond to their sensory experience by building or constructing in their minds, schemas or cognitive structures which constitute the meaning and understanding of their world” (Saunders, 1992, p. 136). Constructivists, writing from this cognitive approach (Ausubel, 1986; Brunner, 1990; Novak, 1998; Piaget, 1966), express the belief that individuals create knowledge by linking new information with past experiences to create a personal process for meaning-making. Within a constructivist framework, the learner progressively differentiates concepts into more and more complex understandings and also reconciles abstract understanding with concepts garnered from previous experience (Novak, 1998). New knowledge is made meaningful by the ways in which learners establish connections among knowledge learned, previous experiences, and the context in which learners find themselves. Lambert et al. (1995) identify multiple principles of constructivist learning theory, which include the following major points: (1) knowledge and beliefs are formed within the learner, (2) learners personally imbue experiences with meaning, (3) learning activities should cause learners to gain access to their experiences, knowledge and beliefs, (4) learning is a social activity that is enhanced by shared inquiry, and (5) reflection and meta-cognition are essential aspects of constructing knowledge and meaning (pp. 17-18).

Novak (1998) operationalized constructivist learning theory by creating concept maps. “A concept map is a schematic device for representing a set of concept meanings embedded in a framework of propositions,” (Novak, 1984, p15). Concept maps are created with the broader, more inclusive concepts at the top of the hierarchy, connecting through linking words with other concepts that can be subsumed. This tool helps facilitate understanding of conceptual relationships and the structure of knowledge. Novak (1990) found in an analysis of multiple studies using concept maps that the technique promoted novel problem solving abilities, raised mean scores on achievement of content units, decreased students’ anxiety levels and increased students’ positive attitudes toward the content of study.



In order to study how constructivist strategies impact the learning of adult students, constructivist teaching strategies were employed in two graduate courses in an adult education graduate program.

### 3 Research Questions

In this study, adult students were taught to use concept maps. The extent to which this strategy contributed to a change in learning strategies was assessed by evaluating: (1.) the change in student concept map scores during a one-year time frame, and, (2.) adult student response's to tape-recorded interviews. The following research questions were advanced to guide this investigation.

- Do constructivist learning strategies (i.e. concept maps) contribute to the success of the adult students?
- When adult students learn to use concept maps in one course, will that learning strategy carry over to subsequent courses in which the student enrolls?
- How does the use of concept maps as a learning strategy change the thinking of adult students?
- Can concept maps transform adult students' prior learning strategies?

### 4 Methodology

During semester one, adult graduate students in two different courses were taught to use concept maps as an integrated part of their course work. Students developed concept maps to reflect the course readings, plan course projects, and to compare and contrast information from course discussions. Twenty-one students from these courses were randomly selected and invited to participate in this study. Following IRB approval, students gave consent to have their course work reviewed and to be interviewed twice over the academic year.

A mixed-method design using both quantitative and qualitative analysis was created for this study. The first and final concept maps created by study participants in the first semester were scored according to the scoring formula created by Novak and Gowin (1984). Reliability was established by obtaining two independent scores on each map. Inter-rater reliability was established at .80. Data analysis included calculation of group means and comparison of these means using a dependent t-test.

At the end of semester one, interviews were conducted with participants about their use of concept mapping. During the interviews, adult graduate students were asked the following questions: 1. What was it like to use concept maps as a learning strategy? 2. What did you learn while doing concept maps? 3. Where else have you used the maps since the completion of your course (if at all)? 4. How was doing the maps the same or different than other learning strategies you have used previously? 5. What did you like most/or like least about using concept maps? 6. What changes, if any, did you see in your thinking ability since using concept maps? 7. What was the most significant learning you remember from this course? 8. If you were going to describe concept mapping to another graduate student, what would you say? 9. How do you see using/or not using this learning strategy in the future?

Study participants were followed during semester two. Concept maps created by the adult graduate students at the end of semester two were scored. At the end of semester two, study participants were interviewed a second time to determine if they continued to use concept maps as a learning strategy and how that strategy impacted their thinking and learning.

Interview data was analyzed using a modified constant comparative method (Glaser & Strauss, 1967; Patton, 1990). First, all interviews were coded and themes identified using the qualitative data analysis software package N\*VIVO. Then, coded data were compared from the first set of interviews to the final set of interviews by developing a system of matrices for comparison and contrast (Miles & Huberman, 1994). Finally, a summary concept map was created to synthesize the themes identified in both sets of interviews.

### 5 Findings

Findings from this study indicate that using concept maps impacts adult graduate student learning. The presentation of findings from this study will first focus on the changes in concept map scores and then explore student interview data related to learning with maps and the use or non-use of maps at a one-year follow-up.



### 5.1 Changes in Concept Map Scores

In this study concept maps were collected from participants at three separate points. In the first semester of the study, the first and final map created by the students were collected and scored. During the second semester, the final map that participants created, (if they did create a map in semester two), was collected and scored.

Data analysis (Table 1) demonstrates a group mean of 44.81 on the first concept map and 121.43 on the final concept map of the first semester, for a difference of 76.62. The t-value comparing the first to final map was  $-6.614$  ( $p=.001$ ). The data indicate a statistically significant difference between the first and final map scores of the first semester.

**Table 1**  
Changes in Concept Map Scores over First Semester

Variable	No. of Cases	Mean	Difference
First Map of Semester 1	21	44.81	-76.62
Last Map of Semester 1	21	121.43	

**P = .001 t-value = -6.614**

Students were followed during the second semester of the study, to determine if they continued to use mapping as a learning strategy and if they did how the maps compared to the first semester. Data indicate that 65% of students in this study continued to use mapping into the second semester. Data indicate the mean score for the last map during semester one was 121.43 and the mean score for the last map in semester two was 120.22, for a change score of  $-1.21$ . The data indicate no significant difference between those participants mapping at the end of semester one and those mapping at the end of semester two.

Participants were also interviewed at two points during this study, at the conclusion of semester one and at the conclusion of semester two. Participants were asked during the interviews to describe their experiences with mapping as a learning strategy and to analyze how their thinking had changed or not changed through the use of mapping. Participant responses were categorized into two areas for presentation of findings: learning with maps and map use on follow-up.

### 5.2 Learning with Maps

Study participants indicated that to learn effectively with maps, they first had to develop the skills in map construction and to understand the mechanics of mapping. Additionally, participants reported that often their initial reaction to mapping changed and developed over the time that they used mapping.

Participants stated that part of what they enjoyed about the process of mapping was the focus on organization, analysis and understanding. Participants indicated that through the process of organizing and analyzing, they developed a more holistic picture of what they were learning. One participant stated:

*It made you look at whatever it was you were doing in its entirety. It made you look at it as a whole. And then start breaking it down by concepts and then you would rebuild it by linking . . . You feel the knowledge building. You just feel yourself seeing things differently than before you started doing that.*

However, some participants expressed three difficulties in developing maps: finding time to complete the maps, deciding on the level of detail to include and overcoming their lack of desire to change how they learned. Participants indicated that mapping as a learning strategy was too demanding and took up too much time

*. . . it is just another task to do when you feel overwhelmed. It takes more time than just reading the text . . . I think it has a lot more value than what it feels like you are doing at the moment.*

Participants also expressed how difficult it was to change learning strategies that they had used in the past. Changing old habits was time-consuming and difficult for most participants in this study. One participant indicated:

*But, I guess what I hated the most was that I had to change my thinking mode. It is before, like, well, I am just reading this information, and I am picking out what I see is in the writing or what the writer is trying to present. I guess I just didn't like the idea of changing old habits and doing things differently.*



### 5.2.1 Understanding One's Own Learning

A major finding of this study was that concept mapping helped adult students to understand their own learning processes. Additionally, they were able to explain that they developed their learning processes through the use of learning strategies such as linking, developing interrelationships, creating meaning schemes, and constructing knowledge. Participants reported that the maps helped them to understand how they think, to think in a broader fashion, to search out complicated relationships, and to organize information so that they remembered it in a much more comprehensive way. For example,

*I learned a little bit about how I think based on how I put the concept map together. I learned a little bit about what challenges me, what comes easy to me. I tried to pick things to concept map that I didn't understand so that I would understand them afterwards.*

Another participant described how she developed an understanding by moving from larger concepts to smaller concepts and back again.

*I learned to use another part of my brain. I learned also to think globally because this is going from big ideas and main ideas to smaller ideas, subtopics, so I learned to modify how I think about information. I also learned to show more linkage of information.*

Finally, participants discussed how the maps helped them apply information to their experiences and at the same time remember that information in a new way.

*. . . instead of it being information given to me and stored away in my head, the most significant thing is that when I can apply things to my real life experience, I have a better time understanding them, better time remembering them. So to me that is a big deal.*

### 5.2.2 Learning Strategies

As participants came to understand their own learning processes, they also articulated of a number of learning strategies that they employed as a result of creating concept maps. Participants reported that their understanding of how to link concepts, develop interrelationships, create meaning schemes, and construct a knowledge base developed through the use of mapping.

**Linking.** Participants in this study were asked to describe what was their most significant lesson learned from the courses they were enrolled in during the first semester. A large percentage of the participants expressed that learning to link concepts was a new learning strategy for them and a major discovery in their own learning. The following participant expressed the value in learning to link concepts this way:

*What I discovered in my own learning was that indeed there were connections between ideas and concepts that I hadn't picked up on just in reading the material. But it was in the diagramming of the concept map and I usually did it in two stages. My first stage was I threw enough stuff down on paper as I could [sic]. My second stage, I let it sort of sit and simmer like a pot on the back burner for awhile. Then I would come back and make some aha's, oh I see some relationships here. And that helped to open up the interconnectedness of what I had been looking at and didn't initially see.*

Another participant expressed a common theme evident in many adult learners' experiences in this study. Participants indicated that they just had not thought about the relationships between concepts previously until confronted with a learning strategy that asked them to make those connections. When asked about significant learning strategies one participant stated:

*The linking. I never gave it thought before. The relationships between levels in the hierarchy and between different concepts within the map. That would probably change my approach to a lot of things now.*

**Interrelationships.** Participants in this study also described a step beyond linking. They indicated that as a result of making links between concepts, they began to really understand and search out interrelationships between concepts that created new meaning for them. As one participant explained:

*As I did the concept maps, I was particularly sensitive to find what the interconnections were. I did our case studies and I went through the readings; whatever we had to concept map, I was more aware of*



*the connections, what are the relationships, because I knew eventually I had to produce that in the map.*

Another participant described how after learning to make links, the process of developing interconnections helped him critique his own thinking by highlighting false connections he had made previously. As a result, he felt that finding the connections was a way of double-checking his understanding of new material.

*After I did a couple of maps I realized that these were the things that I was trying to do mentally. Sometimes I would see the mistakes or let's say just mis-connections. Like no, this really doesn't connect to this. This really should connect over here. You could almost, like, check your math. It is like doing math the long way as opposed to taking some shortcuts. Every once in awhile you made a mistake and then you had to go back. It was kind of like long division.*

**Creating Meaning Schemes.** A number of participants also indicated that subsequent to linking and searching out interconnections, the mapping exercise fostered the learning process or strategy of creating meaning schemes. Most participants described these schemes as a way to organize and structure information. Additionally, participants indicated that in the process of creating schemes of information their ability to recall the information was improved.

*Well, doing the concept map forms the schemes for learning. It forced me where the author didn't put a framework, to put one. So I believe that although it takes longer to read and do a concept map in order to retain what you are doing or to develop an idea that way, that I definitely knew after doing a couple that the retention was going to be greater because the scheme was etched in your mind then.*

**Knowledge Construction.** Finally, participants indicated that through the process of developing a concept map, they learned that linking, developing interrelationships and creating mental schemes all helped them develop their ability to construct a knowledge base for themselves. One participant expressed the way she began to understand the process of creating a concept map as similar to creating a mosaic. She stated:

*I think that helped with the whole process because with a mosaic you have a bunch of little pieces and you are kind of figuring out what is the best way to array them, how many little pieces you have, and what comes after what. That concept plus the learning fell in with my understanding or belief of how adults learn. I guess it would be kind of a constructivist approach as we build on what we already know, we add too, we might reshape what we already have in our brains, based on what new stuff comes in. It may be reshaped or you may just add to your database. I felt like the concept mapping process really helped with that.*

Another participant describes a similar connection between developing concept maps and constructing knowledge. She stated:

*I really believe in concept mapping because I believe in constructing knowledge. Dialog, discovery, constructing knowledge, all that stuff. It really does fit in. Maybe that is why I do like it because it does give you a chance to kind of sort stuff out and construct knowledge.*

### 5.2.3 Changes in Thinking

At the conclusion of the first semester of this study, participants were asked if their thinking changed as a result of the use of concept maps and, if so, how. Participants described how this strategy was different than other learning strategies and that their thinking did change. Participants expressed how they analyzed concepts in more depth and they felt they had the ability to make connections across multiple bodies of knowledge. For example, one participant stated:

*It is different because any other strategy, taking notes, putting together a formal outline, one thing after another. Whereas, the concept map gets you to think outside of the box. It gets you to see how things relate rather than how one thing is broken down. So it was a different way of approaching something, taking a different perspective on learning, I thought, which was refreshing for me.*

Finally, one participant indicated that the mapping process helped her to think better and also helped her to recognize that she really developed an understanding of what she learned.



*I don't know if this makes sense, but concept mapping allowed me to think better. It really allows you to understand what you are reading and as you are doing it, you are putting it together, and all of a sudden when you are done and you think to yourself when you look at sort of the arrows that are going back and forth and the connections that you have made, and you sort of look at yourself and you think, wow, I guess I really get that. I get it thoroughly as opposed to something you just read and five minutes later you asked me what I just read and I am not able to answer the first question.*

### 5.3 Follow-Up After One Year

One of the major research questions this study addressed was do adult graduate students continue to use concept mapping as a learning strategy even when they are in courses that do not require them to do so. In this study, 65% of adult learners reported that they did continue to use this strategy. Those participants who reported that they continued to use mapping explained that they did so for a number of reasons. They seemed to use maps to understand course material in subsequent graduate courses. They also relied on the maps as a way to understand particularly difficulty material. Many participants reported that when they felt “in trouble” in a course or that they “did not get it,” they would try mapping out the material as a way to develop their understanding. Additionally, learners tended to use maps to frame projects for subsequent courses or work-related projects. One participant described how he had a big project to do at work and as a way to help his team understand the scope of the project, he mapped it out and shared the map with them. Another student described how she used a concept map in a subsequent class to demonstrate decision making.

The adult students who did not use concept maps in the subsequent semester (35%), reported that they chose not to because they were not required, they did not have time or they did not have the software they needed to develop the maps. However, the biggest barrier to creating maps for this group was time. Over and over again, these learners complained that the process took more time than they felt they could invest in their course work.

Interestingly, in this study both learners who used concept maps in subsequent semesters and those who did not still reported changes in their thinking at one-year follow up. For example, students who used the mapping tended to report that the maps increased their focus, understanding of relationships, and thinking processes. The following quote is from a learner who did use the maps in the follow up semester:

*I am more conscious, especially in the class I just had, I was conscious of how do these different concepts interrelate. What are the connections that I am making in my mind? That is why I went to the concept map. Because my mind was doing stuff, but I wanted to get it down on paper so I could look at it.*

On the other hand, the learners who chose not to use concept maps in subsequent semesters still reported changes in their thinking. These learners reported being able to identify interconnections, organize information and develop mental schemes for their reading. The following quote is from a learner who had not used mapping in the subsequent semester:

*Although I haven't used them, I think in the way I organize my textbook and in how I write some of my notes, that it is actually a variance of a map. I never used those little stickies before. I highlight them in different colors now. What I will try to do is try to group them according to color, so that when go back I can tell that this one kind of goes with this one which is yellow. This one is hot pink and I have found that it helps to organize in that way.*

## 6 Discussion

Results of this study indicate that adult graduate students learned to develop concept maps and, through the process of using this constructivist learning strategy they developed their thinking abilities and grew to understand their own learning processes. Interestingly, 65% of students continued to use this strategy at one-year follow-up even when enrolled in courses where it was not required that they do so.

A number of issues surfaced in this study. First, it was surprising that many adult graduate students participating in this study began with so little understanding of their own learning processes. Second, it was evident how resistant some students were to changing their learning processes, even when they were unsure of the nature of those learning processes. It took a great deal of work for many students who participated in this



study to find the willingness to try this learning strategy and to learn how to use concept maps. Finally, it was interesting to note that once study participants did understand their own learning, they continued to move forward in developing their thinking abilities even if they did not use the concept map explicitly.

Results of this study support previous work on concept mapping (Novak & Gowin, 1984; Novak, 1998), but also seem to indicate that there is long-term change in participants thinking abilities as a result of learning to develop maps. Additional longitudinal research is needed to substantiate this finding.

## 7 Implications for Adult and Higher Education

This study has implications for faculty in adult and higher education programs. Students in this study demonstrated that concept maps helped them to understand the learning processes of linking, developing interrelationships, creating meaning schemes and constructing knowledge bases. Once they were able to learn in this fashion and explain their own learning, they were much better prepared to function in future graduate courses and as educational professionals promoting learning and change. A number of students shared examples and cases where they used mapping in their organizations to analyze performance projects, develop strategic plans, teach leadership, support decision-making and brainstorm new ideas. The major implication here, for faculty in adult and higher education, is that adult student often do not understand their own learning processes and need practice with learning strategies that will help them develop their learning and thinking abilities. Once students develop more complex learning strategies, they are then better prepared to think critically and analytically about specific content they are learning.

The biggest challenge for faculty in adult and higher education programs is changing teaching approaches to incorporate what we know about adult student learning. Using concept maps necessitates that faculty have a good understanding of constructivist learning and the ways in which maps represent students' thinking. To use this strategy effectively faculty need to create their own concept maps that demonstrate subsumption, progressive differentiation and integrative reconciliation (Novak & Gowin, 1984). Finally, to use mapping faculty need to be willing to foster an approach to learning as meaning construction. This means that the focus of courses shifts from teaching and presenting information to learning and creating meaning. The role of the faculty member shifts from content expert to facilitator of learning. Often this is a demanding change that requires a new way of thinking about teaching and learning.

In summary, this study indicates that concept maps can effectively promote learning of adult students and thus, can be added to the teaching strategies of faculty in higher education. The maps contribute to student success, foster a long-term change in thinking, and contribute to changing adult students' learning strategies. The maps support both constructivist teaching and learning approaches and may have wider applicability to the work world as well.

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