Journal of International Technology and Information Management

Volume 23 | Issue 1 Article 4

2014

A Web-Based Knowledge Management Tool Utilizing Concept Maps for On-Line Student Advising

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ABSTRACT

Increasingly complex program offerings by universities combined with on-line educational opportunities have created a situation where students must deal with an extremely complicated array of curriculum decisions. At the same time, many universities are moving away from the traditional one-on-one advising model toward one that relies heavily on web-based resources. The result of this is that students are often forced to self-advise using complicated and often poorly structured websites. This paper describes a knowledge management tool to mitigate this problem by creating an intuitive, web-based interface to help students navigate directly to the Internet advising materials that are most applicable.

INTRODUCTION

University students are being forced to work within an increasingly complex curriculum environment (Phillips, 2013). This situation has come about because of a number of factors which include the proliferation of programs within the university, the dynamic nature of course offerings and pre-requisite structures, and the prevalence of on-line and mixed-mode courses. One of the main outcomes of this situation is that students require more individual advising than in the past to avoid course selection errors (Bansal et al., 2003; McMahan, 2014). At the same time, the traditional advising model where a student meets one-on-one with an advisor is being replaced with an increasing reliance on Internet-based advising resources designed for "self-advising." (Harris & Harbsteit, 2003; Erickson et al., 2007; Hornak, 2010) Taken together, these two factors create a situation where students are highly dependent on Internet-based resources to navigate an increasingly complicated curriculum structure. In isolation, this would not be cause for concern; however, the reality that most university websites are not designed for this purpose creates the "perfect storm" that is addressed by this research (Kleemann, 2005). Namely, how can students in higher-education programs receive accurate advising in a dynamic curriculum environment using Internet websites that are not optimized to provide this content?

Failure to deal with this situation causes problems for students and university administrators alike. From the students' perspective, course selection mistakes are expensive because they can delay graduation and postpone entry into the workforce (Phillips, 2013). In the meantime, student loans continue to accrue interest and earning prospects are put on hold. From the university administration standpoint, advising mistakes are bad because poorly advised students frequently require special consideration, policy deviations, and can expose the institution to potential legal liability (Swanson, 2006; Ford, 2010). These policy exceptions and related problems dilute the enforcement of the rules and potentially place the institution in jeopardy with accrediting agencies.

  ISSN: 1543-5962-Printed Copy ISSN: 1941-6679-On-line Copy

Various solutions to this problem have been suggested by the literature. Some solutions involve the creation of standalone advising websites designed to provide only advising content (Marques, 2001). Other solutions suggested in the literature depend upon complex student information systems (SIS), some using exotic expert system technologies, to serve as proxies for human advising (Patankar, 1998; Grupe, 2002; Wittenstein & Sharma, 2002; Siegfreid et al., 2003; Hamdi, 2007; Yang et al., 2008; Ahmar, 2011). While these alternatives can be effective, all carry a significant cost. Specifically, independent advising websites often require duplicate content maintenance because they are normally built as a separate entity from the university website (so both need to be maintained). Even under ideal circumstances, some of the content of the advising website may be out of synchronization with the university site and thus provide inaccurate information (Teasley & Buchanan, 2013). Solutions utilizing SIS tools and expert systems have the dual problems of out-of-date content along with the technical considerations of gathering the advising information, converting it into a format usable by the system, and testing it to ensure that accurate advising is provided (Patankar, 1998; Ahmar, 2011). In short, the existing solutions do not adequately solve the problem. This justifies the need for the research presented in this paper.

This paper describes an on-going research project intended to mitigate the student advising problem described above without incurring the complications inherent in the existing solution methods. This is accomplished by creating an intuitive interactive, knowledge management tool designed to access the Internet resources already on-line within the main university website. In this way, students are provided with the on-line advising content that is commonly needed for self-advising without the distracting clutter found in most university websites. In addition, this solution guarantees that the content is always up-to-date and in sync with the main university website because it utilizes the same source documents. The method uses readily available concept mapping software and a standard web browser. It is generalizable to a wide variety of educational disciplines and does not require any special programming skills. It is beneficial because it helps students make better curriculum decisions and helps institutions by limiting the number of special curriculum exceptions.

TECHNOLOGY AND ADVISING

It has been said that "good advising may be the most underestimated characteristic of a successful college experience" (Light 2001, p. 81). However, it has also been stated that poor advising is worse than no advising at all (Mueller, 1961). Taken together, these two statements illustrate both the importance of advising and the fine line between helpful and harmful interaction that academic advisors must walk. This has been the norm throughout the long, dynamic history of academic advising. Even a cursory investigation into its past reveals a discipline that is constantly changing in an attempt to define itself and adapt to the educational environment. The most recent evolution of advising began in the 1970's and continues to the present. At that time, the advising profession began to focus more on diversity and inclusion in the delivery of advising services. First generation, low socioeconomic circumstances, and students with disabilities became hot topics within advising circles. These students tended to be less academically prepared which consequently affected the nature and purpose of academic advising offered (Cross 2000). At about the same time a more aggressive form of advising called *intrusive college counseling* was introduced to deal with this new student segment

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(Glennen, 1975). This advising model was based on the assumption that at-risk students may not be developmentally advanced enough to realize that they need to seek help. Chickering (1973) supported this notion when he wrote that the advisors' job would soon become much more complex and would require a deeper level of involvement in the student's progress.

Over the last 40 years, the advising profession has strived to meet Chickering's vision of increased involvement and support by modifying its function and mode of delivery in order to benefit students. As evidence of this, the decade of the 90s saw a dramatic paradigm shift in the delivery of advising services on campus (Kleemann, 2005). During this period, institutions introduced and subsequently embraced computer technology to supplement the advising function. This change is particularly important given the increase in on-line and distance learning opportunities for students.

The Promise of Technology

The advent of modern computer technology has had a tremendous impact on advising services and the way they are delivered. Erickson found that of the 885 academic institutions surveyed, over 90 percent offered on-line access to class schedules, college catalogs, and on-line courses. Between 80 and 90 percent of this sample also offered on-line registration and admissions via the Internet (Erickson et al., 2007). This shift toward technology-centered advising holds the promise of many advantages for on-site and distance learners alike. For example, at a minimum, Internet-based advising can make the catalog, schedules, and basic advising documents available to students anywhere they happen to be anytime they want. Consequently, it is no longer necessary to travel to the advisor and wait in line to ask a simple question about prerequisites or course availability. This gives the advisor more time to deal with those students who need complex, one-on-one advising attention. In addition, if maintained properly, on-line advising material is always up-to-date and consistent with the catalog. More advanced Student Information Systems can provide access to advanced advising tools such as degree audits, course management, and what-if scenario simulations. These tools allow the advisor working with the student, or the student who chooses to self-advise, to make plans to help navigate a complex curriculum. This level of automated service is appropriate for the current cadre of students because "the majority of these students not only are tech-savvy, but feel technologically entitled. They expect services instantly and on demand" (Honark et al., 2010, p. 80). They are also heavily critical of any web-based system that does not meet their expectations (Feghali et al., 2011). Taken together, these advantages are significant enough to anticipate that more advising functions will be moved to the Internet (Leonard, 2008). Some researchers are optimistic enough to say that the long-term goal, in some situations, should be to put all student services on-line (Shea, 2005).

The Reality of Technology

The promised advantages that technology could bring are seldom fully realized. In practice, Internet-based advising systems exhibit numerous problems. For example, a research study found that approximately 90 percent of all websites have low usability (Teo et al., 2003). This stems from a variety of design factors which can be broken down into the three categories of: data appearance and representation, website access and navigation, and overall information structure (Marsico & Levialdi, 2004). As an example of this, consider that typical campus

websites are structured vertically along academic and service unit silos. Unfortunately, student needs often run horizontally across functional units (Kleemann, 2005). This mismatch of structure versus access results in campus websites that contain all the information, but are difficult to use. Poor usability is particularly troubling for advising websites because students who are attempting to self-advise quickly become frustrated when they cannot locate the information that they need. An additional difficulty is related to website content maintenance. Full university websites generally contain all pertinent advising content; however, they are not structured specifically for advising use. To make it easier for students, smaller satellite websites can be setup for the advising unit. These satellite sites often redundantly store the information found on the main site. Redundant on-line information storage quickly becomes out of synchronization, so the advantage of up-to-date on-line advising information is lost. Teasley and Buchanan (2013) reported an extreme example of this when their research found that only one out of fifty-one (1.89%) of department advising websites surveyed accurately stated the correct number of hours when students were no longer required to meet with an advisor. Finally, acquiring and maintaining advanced SIS tools is an expensive proposition. Whether they are purchased externally or built in-house, the software investment can be very significant. Once operational, the upkeep of the system to ensure accurate advising is equally expensive (White & Leonard, 2003). Should the system include artificial intelligence expert system components, the maintenance and testing expenses are magnified. In conclusion, the real-life outcome of Internet advising systems seldom meets the anticipated expectations. This results in a negative experience for students trying to use the system to self-advise (Shea, 2005).

Stages of Website Development

The main reason for the difference between the promise of on-line advising and the reality is because most advising websites are not at the appropriate stage of development to support students who self-advise. This concept was first described by Darlene Burnett (2002) who developed a four-stage taxonomy of academic website development based upon the functionality of the system. Descriptions of these four generations follow (Burnett, 2002; Kleemann, 2005).

Generation 1—Institutional View: Information is placed on the website using the same silo structure that matches the institution's internal organization. The website is similar to an electronic brochure for each functional area where static content is converted into an electronic format. Only one-way communication is supported and students are expected to navigate from one functional area to another in the same way they would physically navigate campus. The website exhibits no cohesive structure, appearance, or functionality between the different web areas; consequently, it is confusing and difficult to navigate. Keeping the content up-to-date and accurate is a continual challenge.

Generation 2—Content in Context: The website is organized by customer segment at the top level; however, beyond the first page the content reverts to the terminology and structure of the institution. There is little consistency in appearance and navigation after the home page. Some user interaction is possible in that forms can be filled out and submitted, but the bulk of the website is geared toward delivery of static content. There is little or no interaction between the website and the institutional databases. The website is in no way customized to the individual user's needs.

ISSN: 1543-5962-Printed Copy ISSN: 1941-6679-On-line Copy

Generation 3—Personalized Web Portal: The website is organized in a student-centered manner and is designed to handle interactive transactions. The content is customized for each particular student and the website interacts with various campus databases. Depending upon student needs, each student can further customize the site to provide the information that is most useful to them. There is a cohesive look and feel throughout the website along with consistent navigation and terminology.

Generation 4—High-Tech/High-Touch: Generation 4 websites are designed to provide a positive student experience, create a sense of community, and build a lifetime relationship with the institution. These websites are completely customized around the student and his/her needs. They are proactive in that they anticipate student data requirements and automatically provide content to satisfy those needs. This is accomplished by maintaining a database of all facets of the students' academic circumstances and acting upon this data at the appropriate time. All aspects of the high-tech/high-touch website are consistent in look, navigation, terminology, and university branding

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The typical university advising website is somewhere between generation 2 and generation 3 on Burnett's web development scale (Kleemann, 2005). Very few are at the high tech/high touch level and, unfortunately, many are still at generation 1 or 2 status. Based on the descriptions above, a generation 3 website is the minimum level needed to provide the kind of seamless advising services necessary for self-advising students. That means that most students who attempt to self-advise will have a negative experience because the website is not structured for task. Until advising websites can be upgraded to more advanced generations, this problem will continue and students will be faced with the problems previously discussed.

A Novel Solution

It is safe to posit that most universities want to provide advising websites that will allow students to augment traditional one-on-one personal advising with on-line technology tools. Not only is it more efficient, but students demand this access. The only factors holding these institutions back are the expense of acquiring these systems and the difficulty in implementing them. Over time, improvements in technology and web systems design will solve both problems; however, in the meantime, institutions that do not have the resources to implement a high-tech/high-touch website face a dilemma. Their students need the benefits of the on-line tools now, but the institution is not in a position to provide them.

A practical solution to this quandary is to develop a tool that mitigates the problems of generation 1 and 2 websites now so that current students can be better served while the institution collects the resources and will to implement more advanced advising websites. In order to be successful, this tool needs to be relatively easy to create by utilizing existing technologies yet still overcome the major problems inherent in lower-level websites. The remainder of this paper will describe the development and use of a tool that meets these criteria.

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DESCRIPTION OF THE TOOL

An on-line knowledge management tool that solves the problems described earlier must meet a set of criteria and exhibit a number of characteristics in order to be successful. These are described below.

- Easy to build: The web-based system should be easy to create and should not use any complex proprietary software packages. Instead, it should be built using readily available off-the-shelf software tools.

- Easy to maintain: In order to be useful over an extended period of time, the system and its data must be modified to meet the current curriculum environment. Consequently, a successful advising tool should allow rapid updates and rely as much as possible on data already stored (and maintained) by other areas of the university.

- Intuitive to use: The advising tool must be simple to use in order to meet the needs of the largest possible student population. A complex tool that requires special training is not appropriate.

- Complete information, but not overwhelming: The two main problems with existing university web-sites are that they contain too much information and it is difficult to find answers to specific questions. An ideal on-line advising tool should give easy access to the answers that students are most likely to need.

- Multiple modes of information: Different students have different preferred modes of learning and searching for information. Consequently, a good self-advising tool should provide several modes of information retrieval.

Taken together, these criteria describe the general characteristics and functionality of an ideal self-advising tool. They do not specify the low-level details about its construction. This is intentional. By its nature, the advising tool created by this research will be different for each institution. Consequently, a "one size fits all" static specification is inappropriate. There are many ways to achieve the desired results. What follows is a description of the pilot implementation constructed by this research project.

The MCB On-Line Advising Center

The Monfort College of Business (MCB) is a relatively small college with about 900 students within the state supported University of Northern Colorado. MCB offers a single Bachelors of Science undergraduate degree in business that allows students to choose from six different emphasis areas, six minors, and a Masters of Accounting degree. There is not a large on-line or distance program at MCB as most students live on campus. Advising at MCB is performed using a split-model where a professional advising staff deals with freshmen students while faculty advisors work with the rest. Technology plays an important, and growing, role in the

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advising process and, as would be expected, the college has experienced the growing pains typically associated with the move to more Internet oriented advising.

The motivation for this research project was to address the problem that MCB students were often frustrated because they could not find answers to simple questions using the university website. The college advisors were helpful, but extremely busy. A stand-alone MCB advising website was created to solve this problem, but it duplicated the information found in the main campus website and was often out of date. Frequent curriculum changes made the problem worse. There is a desire by advising personnel to create a more unified generation 3 or 4 advising website, but the time, effort, and expense of such an undertaking has delayed its initiation. In the meantime, students continue to be frustrated that they cannot find answers to simple questions via the existing on-line resources.

The on-line knowledge management tool at MCB was created as a stop-gap measure to solve the immediate problems voiced by the students. It is built around a concept map created with the MindManager software package. Concept mapping is a graphical method of indicating the relationships among concepts using hierarchical branches and sub-branches. It is often used to help organize and structure ideas and knowledge. There are several good concept mapping software packages that could have been used for this task; however, MindManager was selected because: (1) it works on multiple software platforms, (2) it has an automated web export feature, (3) it integrates well with other applications, and (4) is stable and relatively inexpensive. Another useful characteristic of the software is that it allows multiple attachments and web links to be associated with each concept. In that way, the relationships between curriculum components can be visually represented along with the Internet and related document content.

The development of the concept map for MCB revolved around the internal structure of the college. Specifically, the initial map consisted of a major "branch" for each department within the college along with a branch for the various minors offered. Each of these branches was, in turn, augmented with sub-branches for the programs within the department. For example, the department of Accounting and CIS was sub-divided into individual branches for the Accounting program, the CIS program, and the Masters of Accounting program. In this way, the internal structure of the organization was mirrored in the concept map. Next, additional branches were added for common university links such as on-line catalogs, liberal arts core links, and miscellaneous on-line documents. The intent of these map branches was to provide direct access to those resources that are commonly needed, but difficult to locate on the university website. Following this links for frequently asked question sites within the university, useful web links, and downloadable data files were added. Once these map components were completed, useful sub-components and attachments were added to furnish additional content to all existing branches. For example, the university catalog branch was augmented with sub-branches for the .pdf version attachments and the on-line web version of the catalog. The intent of these additions was to complete the set of informational links and content that students would find useful. In summary, the process to create the concept map should include the major organizational structure aspects of the college along with any additional informational links and attachments believed to be of use to students. The end result will be different for each college and is likely to be modified frequently based on student needs and organizational changes. Fortunately, the ability to easily modify the map and recreate the website is one of the advantages of the approach

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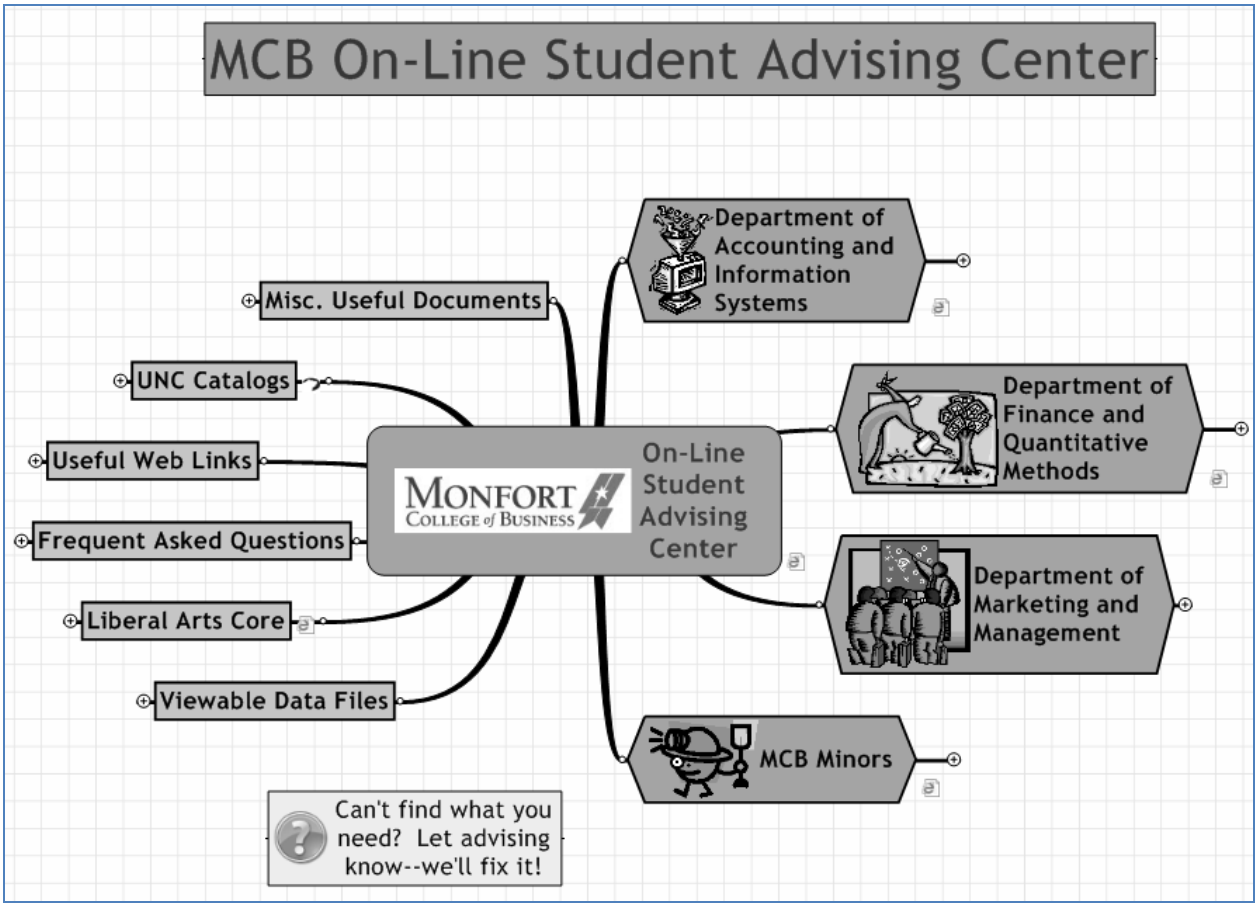
described by this research. The final concept map, expanded to two levels, used to generate the MCB system is shown in figure 1.

Figure 1. MCB advising concept map built using MindManager.



The map is interactive and automatically expands and contracts the branches when the small '+' symbols are clicked on the screen. Each small symbol will open the associated webpage when clicked. In addition, when documents are attached to the concepts, clicking the document symbol opens this content in its associated application.

Concept maps can be built with any number of levels. Figure 2 shows the fully expanded MCB concept map. Although difficult to read, this view illustrates the ability of the tool to incorporate a significant amount of advising information in a relatively compact space.

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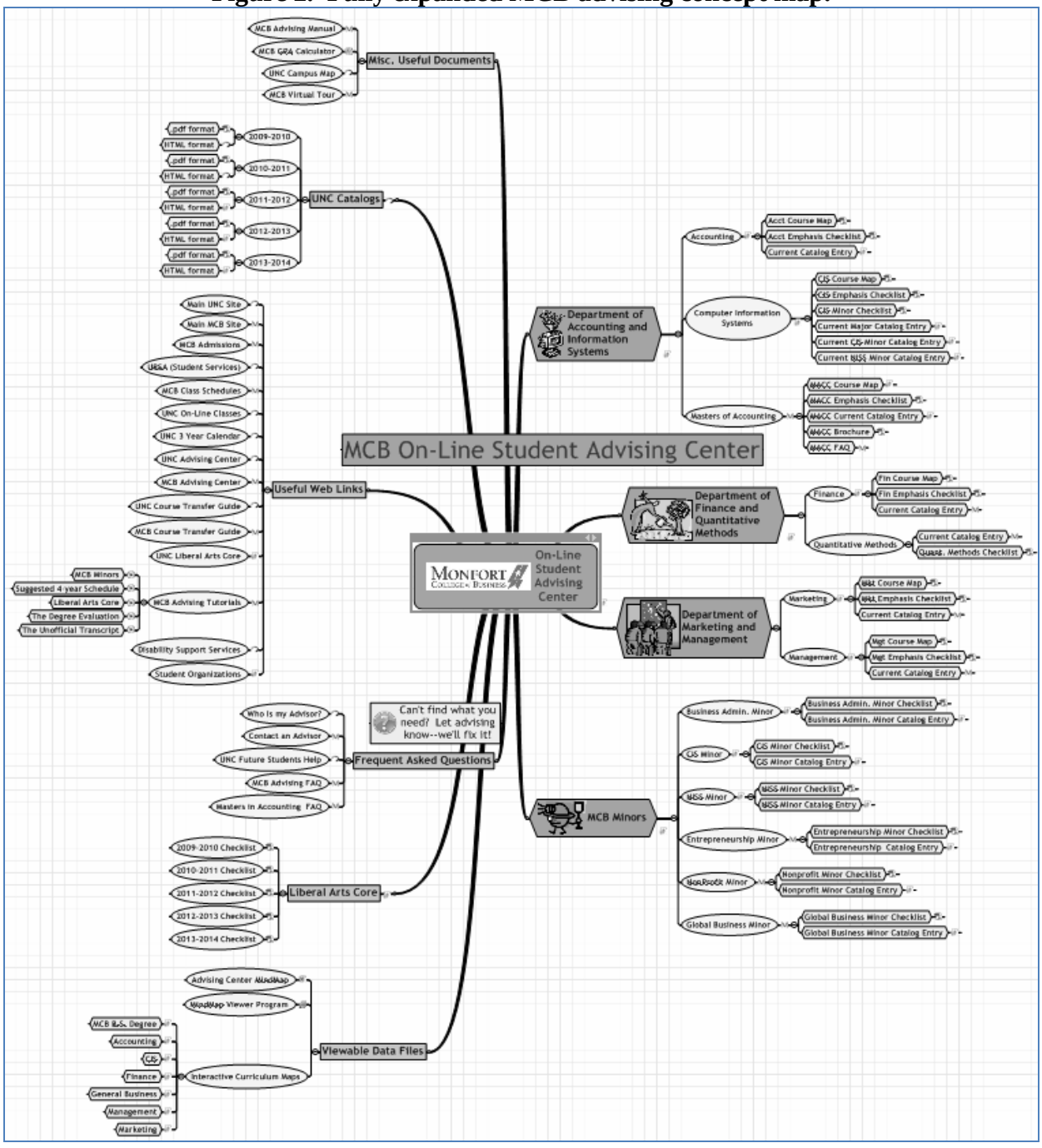
Figure 2. Fully expanded MCB advising concept map.



In addition to its ability to represent complex relationships and link to Internet content, MindManager maps can be exported automatically to fully functional websites. The process is very quick and requires no programming. The end result is customizable via parameter settings, but the default output of the export function is appropriate for most situations.

Figure 3. Home page of MCB on-line advising system.

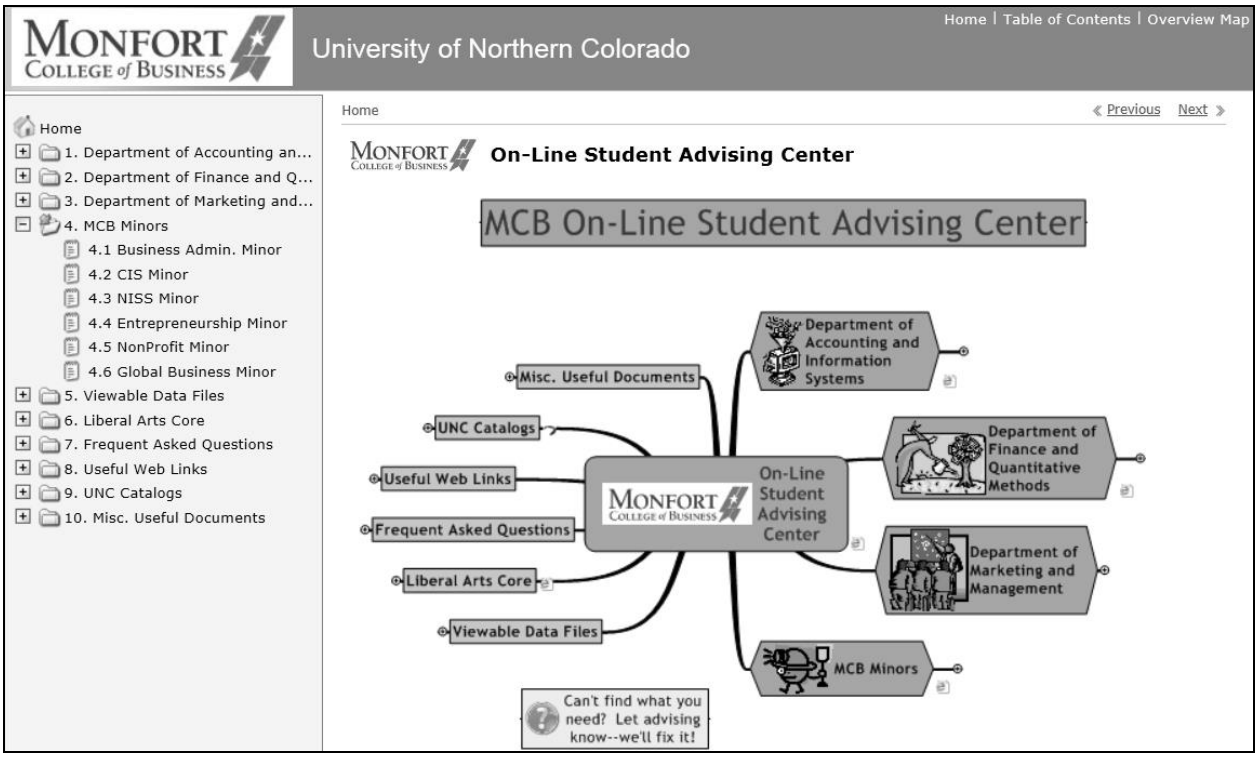
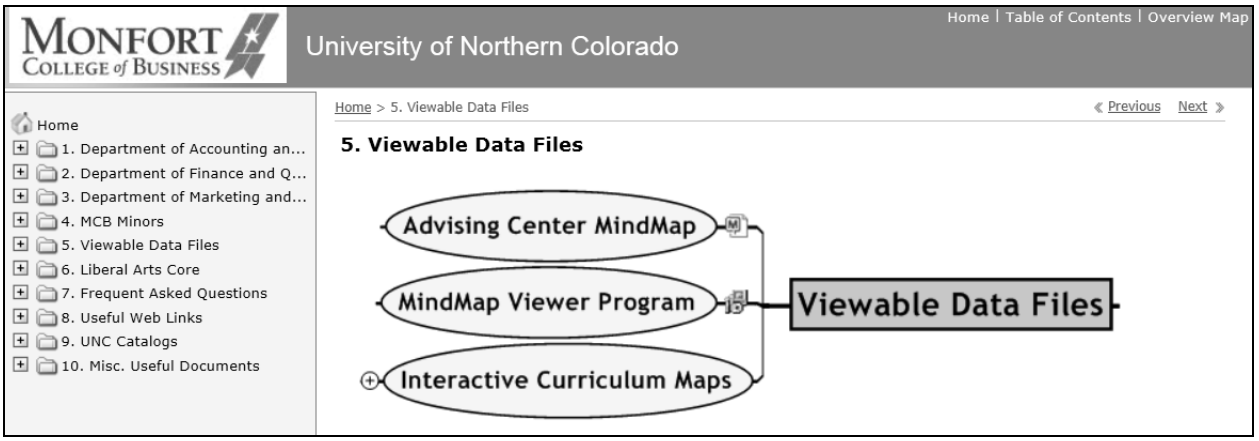


Figure 3 shows the top-level page of the website generated from the MCB concept map. From the image it is obvious that the MindManager concept map was duplicated exactly in the webpage graphic. Also included is a clickable hierarchical index (left side) of all content in a text format. The map graphic itself is interactive and when an icon is clicked, a new page is displayed with the specified content. Figure 4 shows what happens when an individual branch of the map graphic is clicked.

Figure 4. Web page after concept map node clicked.



The map page shown in figure 4 is also interactive, so clicking on the various nodes will either open the related document or move to the next level down in the hierarchy. Another noteworthy feature built into the website is the set of navigation hyperlinks on the upper right. These open the display to the main home page, a text-based table of contents page, and a fully expanded map graphic that can be used to interactively navigate the website. Taken together, these navigation and viewing options provide the ability for users with different data access styles to locate the information content in whichever way best suits them.

DISCUSSION

The on-line tool developed for MCB was designed and built specifically to meet the needs of the college. Other colleges would no doubt devise a different concept map structure. The main point to recognize is that the technique used to build this advising tool is very flexible and broadly applicable to a wide range of educational environments. In addition, this solution meets the five criteria previously discussed for a "good" on-line advising tool. These characteristics along with stakeholder feedback and other noteworthy positive and negative aspects of the tool are discussed below.

Positive Aspects of the Tool

The MCB advising tool is an excellent example of the capabilities of the solution approach proposed by this research. Specifically, using a concept mapping application that automatically generates fully functional websites meets the first two criteria that the system be easy to build and easy to maintain. When the educational environment changes, the concept map can be modified and the website regenerated in just a few minutes. Because the concept map merely points to the source documents that are maintained elsewhere, there is no local data maintenance so the website is always in synchronization with the rest of the university. The on-line advising tool also meets the criteria that it be intuitive to use and present information in multiple modes. Anyone who has used a graphical user interface on a Windows or Macintosh computer is familiar with this paradigm. The additional benefit that website navigation is available through a graphical interface, a text-based interface, and hyperlinks provides students with multiple modes of interacting with the content. The final criteria, which stated that the information be complete but not overwhelming, can be achieved by carefully selecting the content to include in the concept map. Over time, and through student feedback, this content can be fine-tuned to include only the material that is most useful for the general student population.

Beyond these five characteristics, other positive features are available through this approach. The MindManager concept mapping application allows multiple attached documents to each node. These nodes can link to any content that can be delivered or streamed over the Internet, so the possibility exist for the map to link to webinars, videos, databases, and simulations, to name a few. In addition, since the final system is Internet-based, this content is available anywhere in the world anytime it is needed.

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Negative Aspects of the Tool

The approach described by this paper also has a few potential drawbacks, most of which revolve around the selection of content and the generation of the resulting website. In order to be successful, the on-line advising website should provide the most useful subset of available data. Determining this subset will be challenging. The tendency will be to continually add new branches and nodes to the concept map to meet specific student requests. At some point, the bulk of information and the complexity of the concept map will be too much for students to deal with. At that time, the system will be no more useful than the generation 2 university website that it was designed to supplement. Advising departments using this approach should be aware of this problem and strive to avoid it by carefully choosing content to include. A related concern is that there may be some specialized advising content that is not available from the website maintained by the university. In those cases the advising staff will need to generate it independently. Again, this should be kept to a minimum.

Another potentially negative aspect of the approach involves the customization of the resulting website. Using the default MindManager template is very simple and requires no specialized programming knowledge. However, the default template is fairly plain and may not meet university branding standards. If there is a need to make modifications to the template, it will require the services of someone with a programming background. This contradicts the previously stated advantage that the system requires no coding expertise, so it should not be pursued unless necessary.

A final negative aspect of the approach as currently implemented is that it is a passive tool which is not capable of automatically looking up or storing the student's current status within the university. Doing this would require access to the university database and a local mechanism to store the student's previous course selections and preferences. This concern was addressed by the advising staff stakeholders and is a planned enhancement for a future release of the tool.

Stakeholder Feedback

The project is currently in the pilot implementation stage. Because of this, it is not generally available for student use; however, it has been tested by the professional advising staff within the college. The feedback from this stakeholder group indicated that the tool would be useful for students in its current format, but would be much more useful with a few key additions. Specifically, the advising group suggested that the system maintain a record of the student's previous course selections and planned schedules. In that way, they could return to fine-tune their academic plans at a later date within the system. It was also suggested that a set of customizable "quick links" be added to help students jump directly to content areas of interest. Usability would be improved if an "I can't find it" search feature were included and the help feature expanded. Finally, all the advising staff agreed that automatic updates between the University web content and the advising system should be improved to ensure that students would not encounter "dead" website links when University content is moved or renamed. Taken together, these suggestions closely align with the future research goals of the project.

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FUTURE RESEARCH

The web-based knowledge management advising tool described above is the initial stage of an ongoing research project that has the goal of utilizing technology to provide students with easy access to accurate advising information. The creation of this system will help bridge the gap between the services provided by the generation 2 university website currently in place and the students' needs. Several future steps are planned to achieve this goal fully.

- As a pilot test, the current system is successful; however, the real test of its value will not be possible until the general student population has access. Because of this, the next phase of the project is to incorporate the advisor stakeholder feedback concerning help aids and automatic link updates and make the system available to students. These students will be tracked and surveyed to determine their attitudes concerning its usefulness and potential improvements.

- The current system is designed to reside on the campus web server. This has the advantage of being available anywhere there is an Internet connection, but is not helpful for students with poor or nonexistent Internet connectivity. To solve this, an alternate version of the system will be created and copied onto a flash drive that is distributed to students as part of their orientation package. Students receiving this version will be surveyed to determine their attitudes about its usefulness. This version could also be sent out as a marketing tool to prospective students.

- MindManager supports a built-in programming language which could be used to create custom templates to allow a better, more flexible user interface. A future incarnation of the system may utilize this to resolve one of the negative aspects of the current system.

- A more ambitions future implementation will link the system to the campus student information system. This will allow students to access the university database to dynamically build and store schedules and what-if scenarios on the campus server based upon what they need and what is offered; thus creating a more useful, personalized advising tool.

Taken together, these planned modifications show the potential of the approach described by this research.

CONCLUSION

Students in institutions of higher education are facing an advising dilemma. Modern program curricula are becoming much more complex. Because of this, students require more careful and precise advising to avoid costly mistakes. At the same time, technology improvements are moving traditional advising services away from one-on-one human interaction to on-line advising websites. The problem addressed by this paper occurs because most university websites are not designed to locate this information efficiently. This forces students who utilize the technology to spend significant amounts of time and effort finding answers to simple advising

ISSN: 1543-5962-Printed Copy ISSN: 1941-6679-On-line Copy

questions. The end result is poorly advised students who have a negative view of the academic institution.

The solution provided by this research uses concept maps to build an interactive graphical interface to link to the information that is useful to most students. The maps are then automatically converted into a stand-alone website which can be placed on the university servers. The advantages of this approach are that the resulting website is easy to build and maintain, has an intuitive interface that allows for multiple modes of access, and provides links to the subset of information most useful to students. The technique is very flexible and is applicable to a broad range of academic environments.

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