

## **Modular Curriculum Design Using Personal Learning Plans and Reusable Learning Components**

**Jay M. Lightfoot**

Monfort College of Business,  
University of Northern Colorado,  
Greeley, CO 80639  
[jay.lightfoot@unco.edu](mailto:jay.lightfoot@unco.edu)

### **ABSTRACT**

*University-based education is facing direct competition from for-profit corporations over the lucrative lifetime-learning market. This is occurring primarily because universities have not adapted to advances in technology and changes in the educational needs of students. To correct this problem, a new curriculum solution is proposed. This solution is loosely based upon the model curricula generated by professional organizations. The solution utilizes personal learning plans tied to a global learning schema. The end result is a very flexible curriculum delivery model that effectively utilizes modern technology and is potentially superior to any offered by commercial education providers.*

The future of traditional university-based education is at a crossroads. In one scenario, universities embrace modern technology and customer needs to devise programs that meet the requirements of learners in the new millennium. In another potential scenario, the academy continues to deliver education as it has for the last 800 years and slowly loses relevance until it becomes a quaint institution devoid of any real social impact. This crossroads has materialized at this time due to several factors. These include the development of the Internet, the rapid creation of new knowledge in technical fields, the changing demographics of an aging population, and the adherence to traditional curriculum design and delivery by universities. Of these factors, the only one under the direct control of the academy is the curricula and programs offered by universities. Consequently, this paper will propose a curriculum solution designed to create flexible programs to ensure that the university continues to be a viable institution well into the future.

The curriculum offered by most institutions of higher education is based upon a very traditional paradigm. This paradigm requires that knowledge be divided into uniform, semester-sized chunks that are delivered by an instructor to an audience of students who are physically present when the lecture takes place. These chunks are offered at prescribed times during the year and must be taken as an indivisible unit in a specific sequence in order to complete the educational program. While this model may have been satisfactory for generations, it is overly restrictive and does not take modern technology advances into account. Further, it does not consider the needs of the contemporary educational customer. Because of this, innovative change is needed. The motivation for this call to modernize is not based upon the notion that change for its own

sake is good. Rather, it is based upon the fact that external, for-profit ventures are rapidly appearing to fill the void left by inflexible university programs. This void has developed because there is tremendous demand in the workforce for continuing education, and traditional university programs are not geared to meet the needs of the “life-long learner.” The for-profit ventures that are being created to exploit this demand are not bound by the bricks and mortar of conventional universities nor are they tied to educational tradition. Instead, they seek to capture educational market-share by offering innovative delivery options that take advantage of the latest technology and match the needs of the contemporary educational customer. These upstart educational ventures pose a significant threat to traditional universities. Failure to address this problem proactively represents an unacceptable risk to existing institutions of higher education.

This article begins by describing the curriculum problem alluded to above. In this description, the details of the shortcomings that the traditional approach to curriculum design causes and the solutions proposed by corporate ventures are covered. Next, the advantages and disadvantages of “model curricula” solutions will be discussed. These models represent the latest thinking on how best to package programs for students. Following that, a proposed solution will be introduced as an extension to the existing model curricula. This solution has the flexibility to meet the needs of both traditional and life-long learners. Finally, an on-going research project to implement the proposed solution is described and discussed. The challenges and potential benefits to this solution are covered and the proposed solution is summarized.

### **OVERVIEW OF THE PROBLEM**

The United States is becoming an increasingly information driven society. Since the advent of the Internet as a business tool, there has been a dramatic shift from a manufacturing-based economy to a service and knowledge-based economy. U.S. Department of Labor statistics indicate that 80% of all new jobs require computer skills (U.S. Department of Labor, 2006). There are many benefits to this, but there is also a cost. New information and knowledge is being created so rapidly that a college degree obtained today is no longer sufficient to carry an employee through the working years to retirement. While this is not a new trend, the speed that information becomes obsolete has greatly increased in recent years. This is particularly true in the technical fields of information systems and computer science. As proof of this, separate studies by Merrill Lynch and the U.S. Department of Labor found that roughly 50 percent of the information technology skills acquired in college becomes obsolete in three to five years (Maloy, 2000; U.S. Department of Labor, 2006). Older “established” methods and techniques are replaced by newer, more efficient approaches. Because of this, technical knowledge and its associated usefulness has a very short half-life.

The result of this situation is that employees are forced to “retool” on a regular basis to remain competitive and successful. Retooling is the process of learning new skills and preparing oneself for the next career. Recent surveys have shown that the average American will have 3.5 different careers in their lifetime. Within these careers, most will work for ten different employers for an average of 3.5 years each (Aetna Fact Sheet). Each new career often requires another round of retooling to upgrade personal knowledge and skills (Pang, 2007). Because of this, the notion of the “life-long learner” has taken hold. Successful workers of the future will be expected to train and re-train throughout their lifetime if they are to remain competitive.

There are several ways for employees to pursue life-long learning. The most obvious way is to return to the source of the original education (i.e., the university) to acquire new skills. This plan makes sense because the university exists to impart knowledge. Unfortunately, this approach is naive and seldom feasible. University degree programs are designed around a bulk flow model. In this model, students enter the pipeline in mass at the beginning, proceed through a series of introductory courses, move on to a predefined series of intermediate classes, and finish with a relatively small number of electives on special topics. Along the way they are required to take a number of liberal arts, general education, and physical education courses to ensure that a well rounded graduate is produced. This is the classic “school-as-factory” approach whereby students are mass produced in much the same way that automobiles or railroad cars are manufactured.

This system is designed to yield a uniform set of high quality graduates from a large group of inexperienced beginners. It is not designed to allow experienced individuals with obsolete knowledge to jump directly into the advanced special topics courses where the knowledge they seek is taught. Rather, experienced workers returning to college are forced into the mold of a non-traditional student seeking a second baccalaureate degree or into a graduate degree program. Typically, this does not meet their needs. More often than not, the life-long learner wants to retool for career advancement, they do not want another college degree. The predicament they are faced with is to place financial, family, and work responsibilities on hold for several years while pursuing a degree that they really do not want; or to forgo the retooling effort altogether and limit their career advancement potential. This is a dilemma that will likely become more prevalent with time as the workforce ages and the pace of knowledge creation accelerates.

#### Solutions from the Educational Providers

Two distinct groups are aware of this dilemma and are actively pursuing solutions. They are the private sector educational entrepreneurs and the traditional universities. The first group can best be described as investors who are eager to cash in on the new demand for flexible, on-demand education. These investors anticipate large profits, as is indicated by the fact that private investment has gone from \$11 million in 1993 to a peak of nearly \$2.9 billion in December of 2000 (Eduventure 2000, Evans 2002). The model being used by these investors is patterned after the medical community’s health maintenance organization (HMO). So called *EMO’s* (educational maintenance organizations) have been endorsed and funded by a number of prominent Wall Street investors. It is their belief that tremendous profit potential exists in educational outsourcing and professional training. The keys to this success are to streamline the educational delivery process and utilize modern technology to reach a larger customer base (and consequently lower the cost per student). These investors have no allegiance or loyalty to the educational tradition that artificially groups knowledge into semester-size chunks and uses highly paid professionals to deliver training to a small “live” audience of students in a classroom. Further, the programs produced by educational outsourcing companies are available when and where the customer wants and do not require extensive prerequisites, general education coursework, or physical education classes. Thus, their solutions are designed to be innovative, flexible, and customer friendly.

The second group actively working toward a solution for life-long learners is the traditional providers of higher education-- the universities and colleges. This group has several notable

advantages over the corporate providers. They already have the buildings and the experienced personnel needed to deliver training. They also have the systems and infrastructure needed to track and manage a large group of learners. Finally, many universities have state funding sources and name brand recognition as the provider of educational services for the region. Taken together, these factors should allow the universities to easily overcome any startup EMO in the competition for the life-long learner market.

Unfortunately, most universities are bound to tradition and to an outmoded paradigm for educational delivery. This paradigm imposes artificial constraints that result in sub-optimal curriculum solutions. For example, executive MBA programs are a popular way that some universities choose to provide additional training for non-traditional students. These programs normally have an accelerated timetable to graduation and have courses offered during evenings and weekends so as not to disrupt the normal work schedule of the employee. While this represents a noble effort by the university to be flexible and customer centered, it still falls short. Executive MBA programs adhere to the rules of the classic education model. These programs still divide knowledge into semester length courses that must be taken in their entirety in a predefined sequence. Students continue to be forced to take courses that may be of no interest to them (because the courses are required by the degree). Most of the time, the same faculty teach the executive courses as teach the regular version, so the only real difference between the executive and regular programs is in the length of each class session and the time and day classes are offered. This clearly fails to meet the needs of the life-long learner and is representative of the ineffective attempts most universities have made to accommodate this growing group of educational customers.

Other universities have devised more creative solutions. These institutions use modern technology to loosen the constraints of time and space over educational delivery. To elaborate, research on distance learning typically uses a 2-dimensional grid to represent possible modes of instruction (Johansen, Martin, Mittman, & Saffo, 1991). Along one axis of this grid is the time dimension which varies from synchronous delivery to asynchronous delivery. The second dimension determines the place that instruction is delivered. This scale runs from delivery at the site of the presentation to delivery at some distant location. Combining both axes creates the grid shown in Figure 1 below. For simplicity, the two scales are each shown as having two discrete states. Thus, the grid is composed of four possible modes of instruction-- same time, same place; same time, different place; different time, same place; and different time, different place. For ease of reference, the four grid cells are labeled "cell 1" through "cell 4."

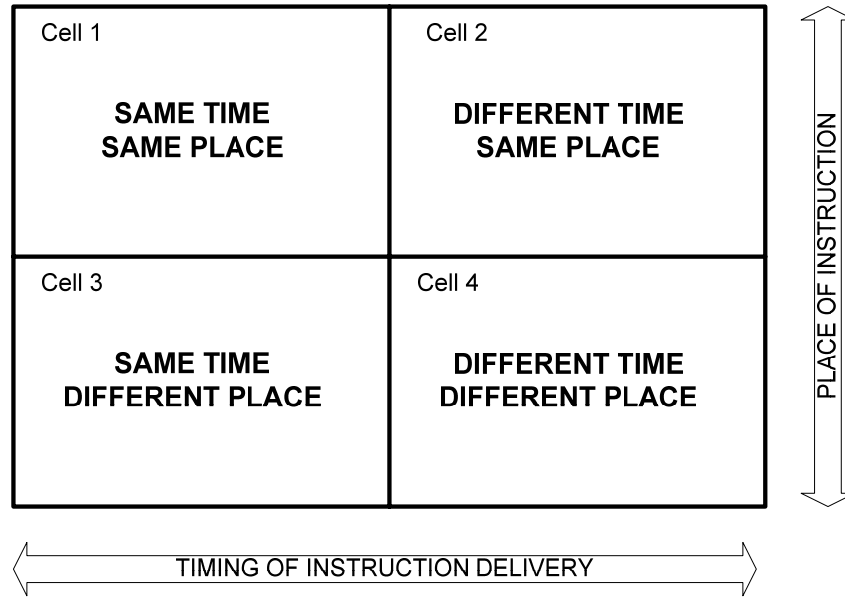


Figure 1: Types of instructional delivery

Cell 1 represents the mode of instruction used by the traditional paradigm. Thus, students must physically be present where the lecture is presented at the time it is given. Moving to cell 3 implies that students at remote locations can view the lecture while it is being given. Instruction using the cell 4 mode allows remote students to view the presentation at a time other than when it actually takes place. By using the internet and multimedia technology, some colleges provide instruction that would fall into all four cells.

This is a step in the right direction because it uses technology to build a more flexible program for students. It is not, however, a competitive solution. Once again, the constraints of the traditional educational paradigm limit the usefulness of the university solution. The most flexible and technologically advanced instruction mode (i.e., cell 4), is still performing the linear delivery of a complete semester-size knowledge unit. Some courses cannot be taken until other semester-sized knowledge units are finished, and the course may teach topics that the working life-long learner does not need for the retooling effort. Once again, the university’s best efforts to compete for the lucrative professional training market fall short because of adherence to the traditional education model.

Universities actually would have to do very little to capture the e-learning market. The only advantages that educational outsourcers have are speed and flexibility. The “speed” advantage allows them to bypass the bureaucratic lethargy common in universities and the “flexibility” advantage gives them the freedom to be creative. Traditional institutions of higher learning have access to all the pieces needed to provide world-class retooling training. The only thing holding them back is the notion that only traditional university-based education “counts” and the belief by some that utilizing technology in the classroom is superfluous.

### Model Curriculum Solutions

Professional societies, in conjunction with the educational community, periodically publish “model curricula” for different fields of study. These curricula are designed to embody the latest thinking into what constitutes the best way to teach a subject for the foreseeable future. In the computer science area, there are several such efforts currently underway. One of the most popular and mature of these is the Computing Curricula report series (ACM/IEEE-CS 2001; Shackelford, et. al., 2006). These model curricula were supported by the Computer Society of the Institute for Electrical and Electronic Engineers (IEEE-CS) and the Association for Computer Machinery (ACM) —the two largest and most prestigious professional societies in the information science field. Because of their general acceptance, these model curricula will likely influence the way computer technology is taught for the next decade.

The 2005 model curricula is an extended and enhanced version of the 2001 report. The latter is based upon the structure introduced by the Computing Curricula 1991 report. Consequently, the model is mature and well thought-out and can reasonably be viewed as a surrogate for similar model curricula in other fields. The structure of the 2005 report organizes the body of knowledge into several “families” of computer related disciplines. For example, three of the families in the CC 2005 structure are computer science, software engineering, and information technology. Each family has a three-level hierarchy. The top level of the hierarchy is called the *area*. An area represents a subfield within a discipline. For example, the computer science body of knowledge is divided into several areas including programming languages, operating systems, and discrete structures (to name a few). Each area can be sub-divided into smaller components called *units*. Each unit is intended to represent “thematic modules within the area” (ACM/IEEE-CS 2001, p. 14). For instance, the operating system area contains twelve units which include concurrency, scheduling, and memory management. Finally, each unit can be further sub-divided into *topics*—the lowest level of the hierarchy. Topics are those identifiable concepts that are necessary to fully explain a unit. For example, the operating system area contains a unit on concurrency. This concurrency unit is made up of ten topics which include state diagrams, interrupts, and multiprocessor issues. Taken together, the ten topics comprise the knowledge that should be covered by the concurrency unit. Figure 2 (following page) graphically shows the relationship of the different levels of the knowledge hierarchy suggested by the 2001 report.

### A New Solution Proposal

Upon examination it becomes clear that the efforts proposed by the model curricula address the symptoms of the problem, not the problem itself. Specifically, knowledge is still divided into discrete units with a specific, linear, sequence of instruction implied. While the model curricula gives curriculum designers a better handle on exactly what is covered and where it is covered, it does not add the flexibility needed to compete with the commercial e-learning providers.

This section will present a new solution that provides both the flexibility and the efficiency needed for universities to compete effectively against the education outsourcers. This solution is loosely based on the model curricula. It requires three components to succeed: finer knowledge

granularity, non-linear knowledge sequencing, and electronic knowledge delivery directly to the student utilizing personal learning plans and learning schema. Each of these components is discussed below.

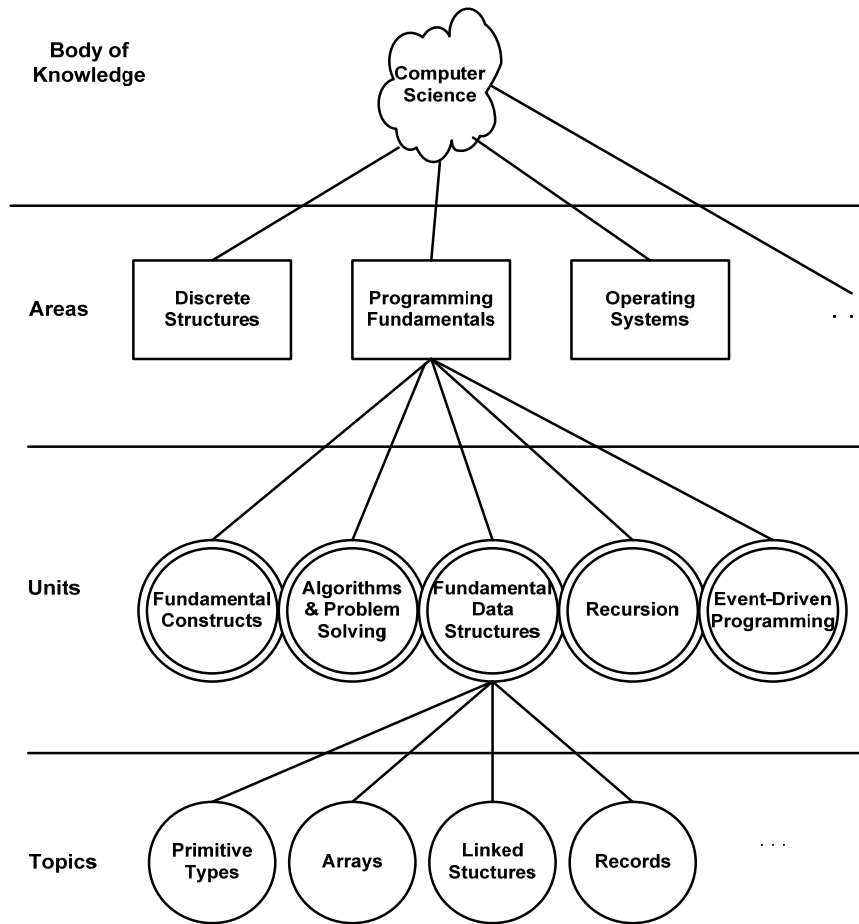


Figure 2: Hierarchy of knowledge from ACM/IEEE 2001/2005 reports

*Knowledge Granularity*

A key problem inherent to the model curricula lies in the size of the knowledge unit that is used to build the program. A truly flexible educational delivery system should significantly reduce the working size (i.e., the *granularity*) of the basic knowledge unit from the semester and topic sizes currently employed down to the *atomic knowledge unit* level (AKU). Knowledge at this level of granularity represents a single concept with distinct educational objectives. A particular AKU need not even be associated with a specific course because it has independent existence and importance.

For example, the computer science realm would contain an AKU for the stack data structure and another for two’s complement binary addition. Both AKUs could conceivably be included in several courses. By breaking knowledge down into low-level units of fine granularity, the

potential exists to create extremely flexible courses that include a number of “required AKUs” along with a selection of “elective AKUs” to give the learner the ability to customize the education to their own personal needs. In a sense, the AKUs are the basic building blocks used to create an education in much the same way that Lego™ blocks can be used to create larger, more interesting structures.

### *Non-Linear Knowledge Sequencing*

Along the same lines, innovative curriculum design requires that the delivery of these AKUs not be tied to a rigid linear sequence. There should be the flexibility to rearrange the order that independent topics are covered. For instance, the AKU on two’s complement addition could be taken either before or after the AKU on the stack data structure without ill effect. In addition, some AKUs need not be covered at all. If a student already understands the stack data structure, there is no need for that particular student to spend time hearing about it again. Instead, the student might want to substitute an AKU dealing with some other data structure of interest. Allowing students to pick the order and, in some cases, select which AKUs to include in a course gives the type of flexibility that the life-long learner desires.

While flexibility is a positive attribute, some structure is needed to enforce AKU prerequisites. For example, it should not be possible to proceed to multi-dimensional array structures before mastering vector arrays. Likewise, higher order topics such as record structures should not be attempted until the lower level data types topic is completed. To enforce these types of structures, an overriding learning schema must be created of all AKUs and their consolidating topics. When applied to the context of the new learning design, the schema supplies the “rules” around which flexible student programs can be designed while still maintaining academic rigor.

### *Personalized Electronic Knowledge Delivery*

Finally, the last component needed to create a truly flexible course is to use a delivery system that allows AKUs to be available whenever the student wants and wherever the student happens to be when learning is convenient. This delivery mechanism should also be tied to a software component to track each student’s “personal learning plan” (PLP). These plans would track those AKUs that the student has taken along with the assessment results of each student after the AKU is completed. It would also provide a link to the learning schema to help guide the student to the next logical topic for their PLP. In this way, student curricula could be customized to the unique needs of each student and the PLP tracking system can be used to maintain academic standards across the program.

The obvious vehicle for this type of delivery is the course web-site over the Internet. Modern technology allows for the storage and asynchronous streaming delivery of multimedia presentations and other educational material. These presentations could be created as small, self-contained lectures on individual AKUs. Each AKU would have its own learning objectives and assessment piece that must be successfully completed before the student is awarded credit for the AKU. The PLP tracking system could be designed in such a way that poor performance on a particular AKU could suggest (or require) students to take rudimentary AKUs before attempting other, more advanced, ones. It would also require that all related AKUs required for a

consolidating topic be completed prior to moving on to other topics. This has a distinct advantage over the traditional classroom because it is student-driven and flexible. It is also much more student-friendly because instruction over the Internet is globally accessible, infinitely patient, and always willing to go over the material one more time.

The general structure created by the addition of the AKUs to the model curricula structure is shown in Figure 3. More importantly, Figure 4 illustrates how various AKUs could be organized into a flexible schema of learning. With the fine granularity of AKUs, nearly limitless variety of structures can be derived from the full schema. When combined with the PLP component, no two student learning plans need be identical; thus, the structure exhibits the required academic standards and rigor (through the assessment component) and the desired flexibility and customizability (through individual student PLPs derived from the learning schema).

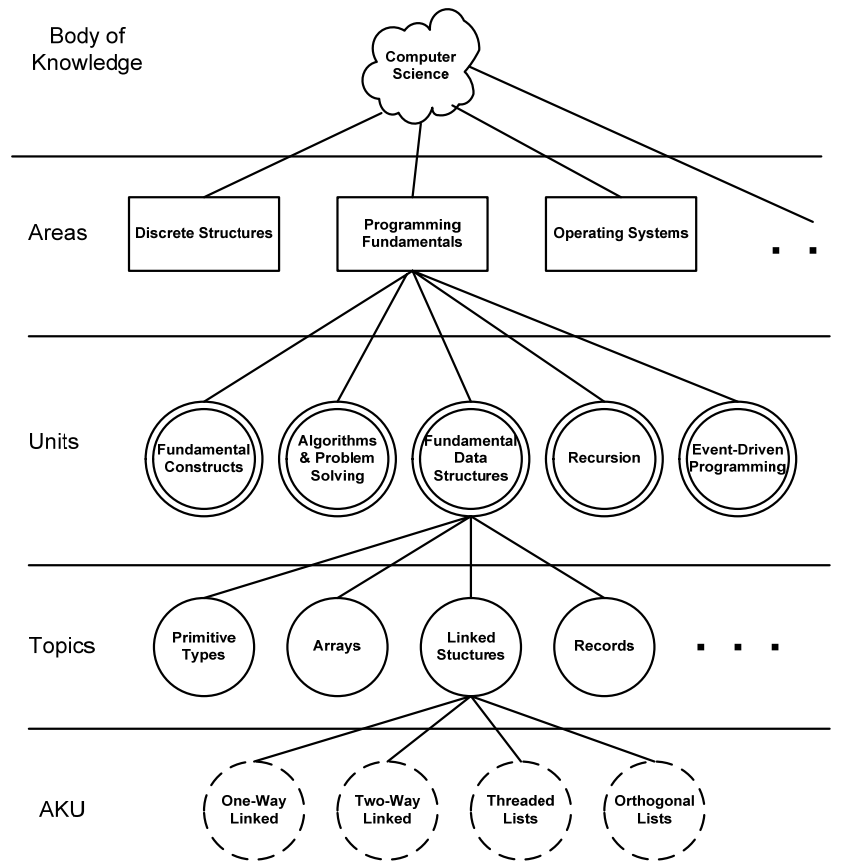


Figure 3: Proposed hierarchy of knowledge

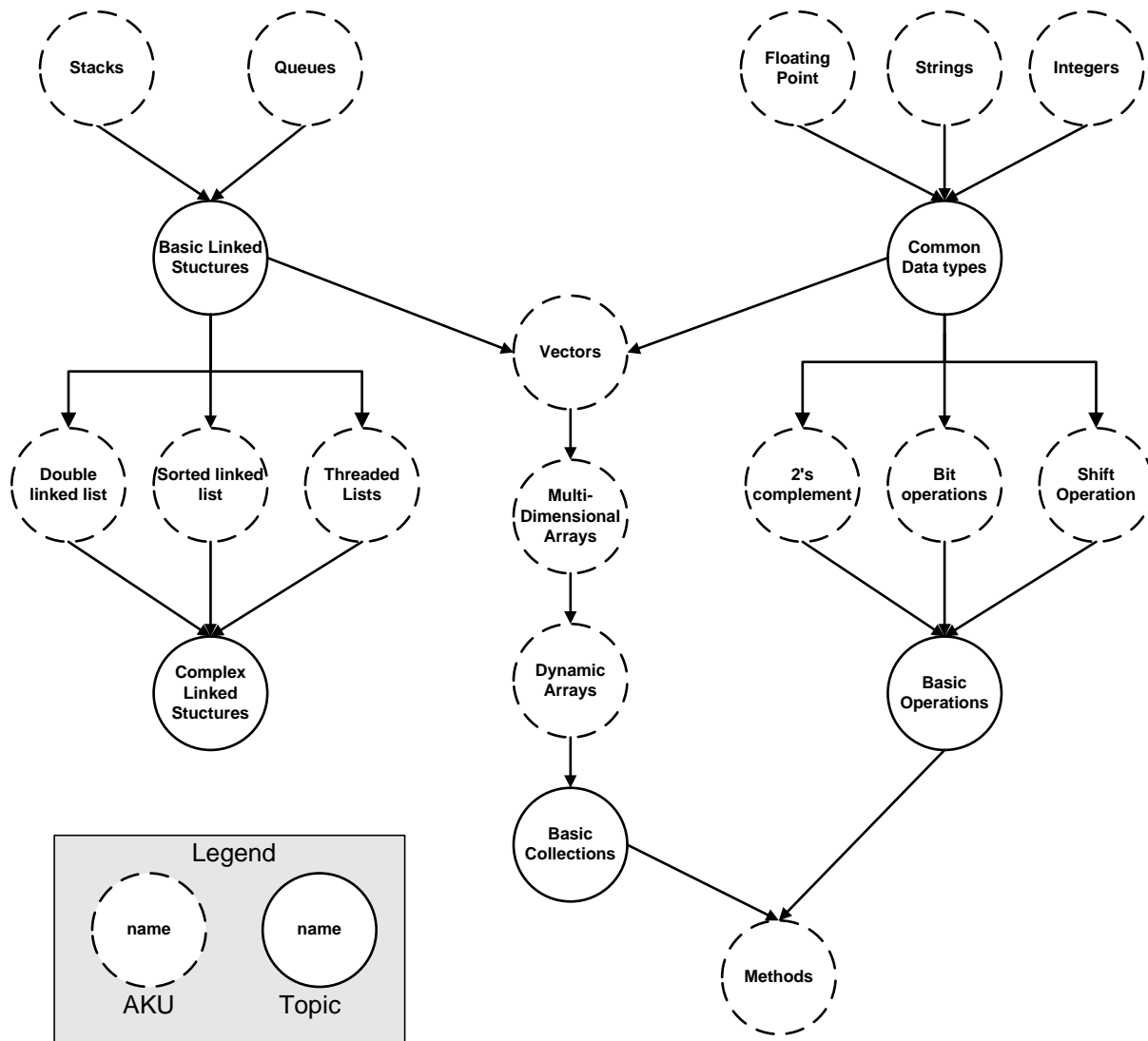


Figure 4: Subset of learning schema utilizing AKUs and topic consolidators

*Comparison to Learning Objects*

The notion of using small, self-contained reusable components to teach students is not new. The *Learning Object* (LO) was created for just this purpose. In 1994, Wayne Hodgins first used the term *Learning Object* to name a working group within the Computer Education Management Association (Polsani, 2003). Since then, a rich literature has developed around the concept. Within the literature, LOs have variously been described as "any entity, digital or non-digital, that may be used for learning, education or training" (Learning Technology Standards Committee, 2002), and "web-based interactive chunks of e-learning designed to explain a stand-alone learning objective" (CETL Reusable Learning Objects, 2007). Multiple large implementations using LOs have been created by major universities and consortiums. They are very effective for the purpose they are designed; however, they do not directly deal with the problems addressed by this research. Specifically, LO systems, as commonly implemented, cover relatively large chunks of knowledge (i.e., the Topic level in the model curricula). They

normally do not have the finer granularity needed for flexible recombination. In addition, LOs commonly address specific topics within a particular course. They normally are not designed for wider use across the entire curriculum. Finally, and most importantly, LO management systems tend to be geared for instructor use. That is, instructors create an online course by combining existing LOs into the course that they want to present. This misses the main point of allowing the course to be learner-centered. To be truly flexible, students should select the modules that they want to learn and are important to them. Of course, this level of student control is only possible if a strong learning schema is present to guide (and require) students to select a group of AKUs that support their interests. The majority of LO systems have no direct equivalent to this learning schema component.

### **PROGRESS TOWARD SOLUTION IMPLEMENTATION**

The proposed curricula solution described above is being implemented by an ongoing research project that is composed of three phases. The first phase creates a blended learning environment that combines the best traditional teaching methods with the most effective modern technology components. This curriculum design utilizes the Internet and several readily available software tools to deliver the technology components. The second phase of the project creates a sample learning schema for a single course and builds the PLP management system to utilize the schema. The final phase merges the blended learning environment with the PLP management system and tests its effectiveness in an actual class. Phase one is largely completed and is currently being pilot tested on students in an actual classroom setting. Preliminary results are very promising and show that students perceive the new blended course design to be very effective. Phases two and three are currently under development. Progress toward completion is described below.

#### *Phase Two Progress*

Generating a full learning schema and its associated content is an extremely tedious and time consuming process. In order to move the project along and not become bogged down in irrelevant details, the decision was made to create a very superficial learning schema for a single course to determine proof of concept. This schema would necessarily not include a realistic depth or breadth of coverage. Instead, it would have sufficient detail to test the functionality of the associated PLP management software. Figure 5 shows a graphical representation of the pilot learning schema that was developed for phase two of this project.

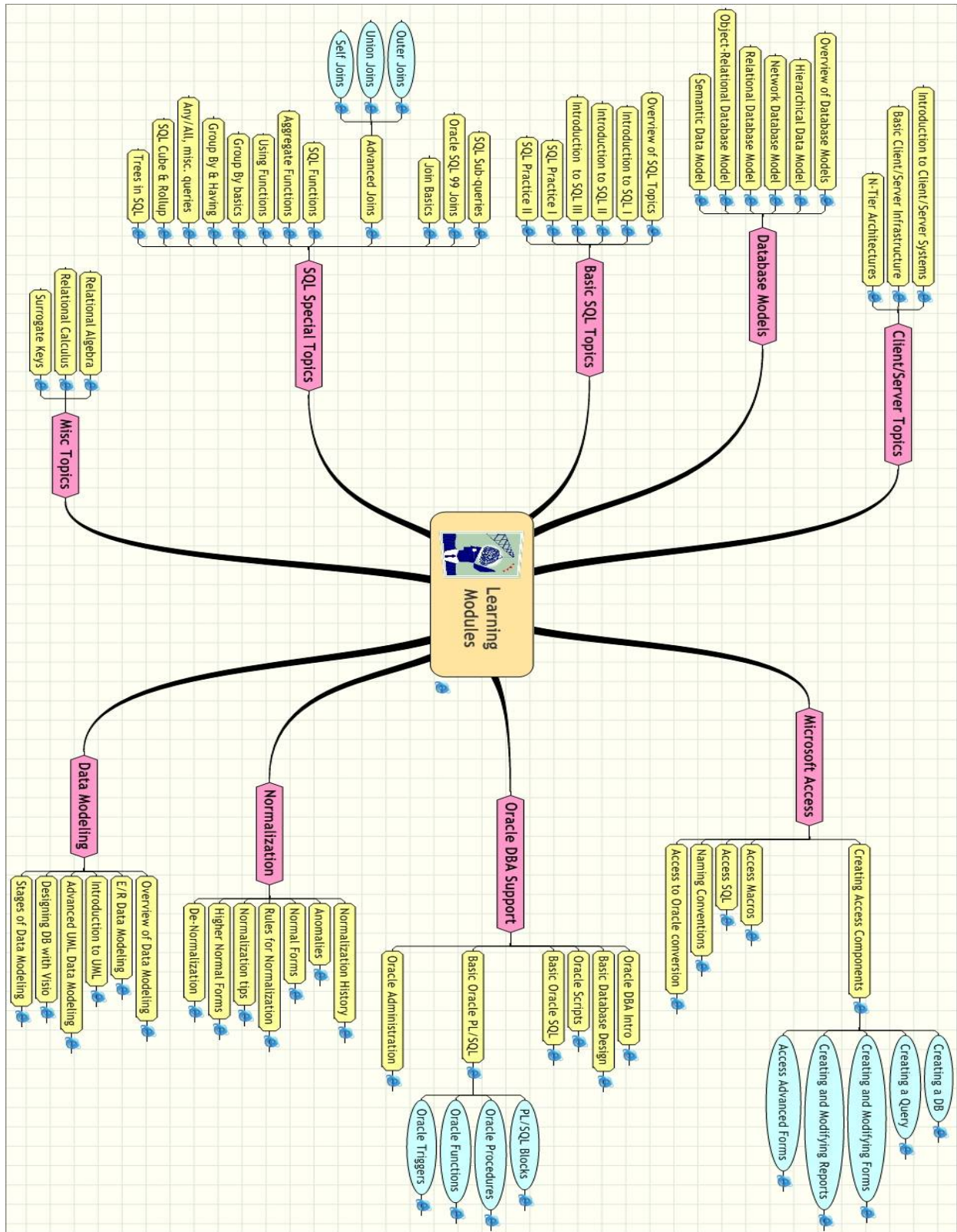


Figure 5: Pilot learning schema

The software used to create Figure 5 is MindMap 6 Pro<sup>TM</sup>.<sup>1</sup> This software package was chosen because it creates concept maps (i.e., graphical representations of abstract concepts and their associations) and also has a built-in scripting language similar to Visual Basic. With this language, a system can be built to interact with the user and generate a unique PLP. For example, if the student were looking at Figure 5 on the computer screen and wished to create a PLP, they would use the mouse to click on the modules of interest. When clicked, the modules would change color to indicate selection. After the user had selected all the modules they wished to take, they would click a “generate PLP plan” button and the learning schema rules would be applied to create a new concept map that included only those modules the student selected along with required prerequisites.

This PLP would also graphically indicate the order that modules must be taken. The rules for prerequisites and ordering can be stored in any ODBC database (such as Microsoft Access<sup>TM</sup> or Oracle<sup>TM</sup>) along with the data needed to generate the PLP graphic. Thus, at any time in the future, the student could log in and interact with their PLP. By clicking on the modules shown in the PLP, the student will be able to access the material of the module and “take” the AKU. Afterwards, depending upon their performance on the module, the PLP map will indicate completion by changing the color of the module on the map. If the student later realizes that they need more information, they can re-generate the PLP with additional modules selected. All modules taken to date will still indicate completion. Progress toward completion of the PLP generation component is promising and a full scale pilot test is planned.

### *Phase Three And Beyond*

Once the PLP management software is complete and a reasonable learning schema is created, the components will be incorporated into the blended learning environment described above. This environment contains many technology components, so the PLP system will be a part of the larger experiment to see which technologies are effective in the blended curriculum design. Assuming that the PLP component is useful and viable, it will be separated out and applied to strictly online classes to address the problem of curriculum flexibility initially described by this paper. This somewhat circuitous route was intentionally chosen to make sure that the technology behind the PLP solution works in a blended environment (where face-to-face instructor interaction is available) before moving it to the more difficult online environment (where instructor interaction is restricted). In this way, the major technical and interpersonal problems can be worked out prior to full implementation.

### **Challenges and Limitations**

The primary challenge for this project is the difficulty in creating a full and usable learning schema with associated content. This is a monumental undertaking that will require the work of literally dozens of others. As an example of the scope, the LON-CAPA project (which uses Learning Objects but is still a reasonable comparison) has been in progress since the late 1990s. To date, over 40 colleges and universities are participating and have collectively created over 60,000 shared e-learning resources (LON-CAPA, 2007). Because of the potential scope of the

---

<sup>1</sup> MindJet Corporation <http://www.mindjet.com/us/>.

final product, this research described by this paper has intentionally been geared to provide proof of concept results only. It has not been designed to produce a full and complete product. To a certain extent, this could be viewed as a limitation; however, it is a limitation that is necessary if the basic design work is to be completed within a reasonable timeframe.

A second challenge revolves around the changing nature of the Internet and its associated technologies. Any system designed to work with the Internet as it exists today will likely be obsolete in the near future. As an example, consider Internet2 (a.k.a., UCAID). This project aims to redefine how the Internet is used through the development of revolutionary technologies (Internet2 Organization, 2007). Many new and exciting developments have already been put forth by this group. Because of this and other similar projects (Venkatraman, 2004), the infrastructure used by the PLP system is a dynamic moving target. This creates a challenge to build a flexible structure that is not dependent upon specific features of existing infrastructure and browser products. Research to build this type of dynamic, knowledge-based network is underway on several fronts and is making good progress (McManus & Snyder, 2003; Seng, J. & Ying, M., 2004; Wang, J., 2005).

A final challenge faced by this project is resistance to change by the academy. As was initially stated, the current university system has existed for hundreds of years with very little real structural change. Because of this, it is reasonable to assume that change as radical as this project proposes will be met with resistance. Add to this the stubborn notion that the for-profit EMOs do not pose a real threat to higher education and you have the makings of a very difficult path to implementation and full acceptance by the rank and file instructor. However, despite the difficulty, change must occur or the current system of education delivery provided by traditional universities will fade into irrelevance.

### **SUMMARY**

Traditional university-based education is facing growing competition for the lucrative “life-long-learning” market from for-profit organizations. These organizations are becoming a popular alternative to traditional educational institutions primarily because they offer flexible programs that better serve the needs of the student customer. This is a dangerous trend for the university as an institution because failure to adapt to the changing environment could modify the public perception of a traditional university-based education from dynamic and progressive to quaint and inconsequential.

Several possible solutions to correct this problem were examined; including special programs offered by universities for executives and “model curricula” developed by professional organizations. All were found lacking in that they only address the symptoms of the problem, not the problem itself. Specifically, the problem is that traditional education divides knowledge into semester sized chunks that must be taken in a strict linear sequence. This curriculum paradigm is an ingrained tradition for almost all universities. Unfortunately, (for the university) the for-profit EMOs are not bound by this tradition. They are able to offer flexible programs over the Internet that divide knowledge into much smaller, bite sized pieces that are selected by students.

To counter this problem, a new curriculum solution was proposed using a model curriculum as a

basis. This proposal depends upon three components: finer knowledge granularity, non-linear knowledge sequencing, and Internet-based delivery utilizing an overriding learning schema and student personal learning plans. These components were discussed and shown to have the characteristics necessary to offer a flexible program similar to that offered by the EMOs while still maintaining academic rigor.

The project to implement this proposed solution is currently underway. The first phase, which built a blended learning environment to test technology components, is largely complete and appears to be successful based upon student perceptions. The next two phases, which will build the learning schema and the PLP management system, will be incorporated into a pilot test. The final incarnation of the solution will be to implement it as a stand-alone Internet learning system. This system will be capable of competing directly with the EMOs in terms of flexibility and should, if designed properly, satisfy the university imperative of academic rigor.

## REFERENCES

- ACM/IEEE-CS Joint Curriculum Task Force. (12/15/2001). Computing curricula 2001 computer science. Retrieved from <http://campus.acm.org/public/comments/cc2001.pdf>.
- Aetna Fact Sheet. (2007). Retrieved from [http://www.aetna.com/news/kits/planyourhealth\\_factsheet.html](http://www.aetna.com/news/kits/planyourhealth_factsheet.html).
- CETL Reusable Learning Objects. (2007). Retrieved from <http://www.rlo-cetl.ac.uk/faqs.htm>.
- Craver, I.W. (1994). School library media centers in the 21<sup>st</sup> century: Changes and challenges. Westport, CN: Greenwood Press.
- Eduventure. (2/2000). Private investment approaches \$1.0 billion. *The Education Quarterly Investment Report*. Retrieved from [http://www.eduventures.com/research/industry\\_research\\_resources/EQIR\\_2000\\_Q1.cfm](http://www.eduventures.com/research/industry_research_resources/EQIR_2000_Q1.cfm).
- Evans, T. (2/2002). Education investment themes for the next bull market. *The Education Quarterly Investment Report*. Retrieved from: [http://www.eduventures.com/about/press\\_room/02\\_20\\_02.cfm](http://www.eduventures.com/about/press_room/02_20_02.cfm).
- Harris, K., Logan, D., & Lundy, J. (July 3, 2001). E-Learning: Ten big trends worth watching. Gartner Advisory, Gartner Group.
- Internet2 Organization. (2007). Retrieved from <http://www.internet2.edu/about/>.
- Johansen, R., Martin, A., Mittman, R., & Saffo, P. (1991). Leading business teams: How teams can use technology and group process tools to enhance performance. Reading, MA: Addison-Wesley Publishing Company.

Learning Technology Standards Committee. (2/15/2002). IEEE standard for learning object metadata. IEEE Standard 1484.12.1-2002. Institute of Electrical and Electronics Engineers, New York. Retrieved from [http://ltsc.ieee.org/wg12/files/LOM\\_1484\\_12\\_1\\_v1\\_Final\\_Draft.pdf](http://ltsc.ieee.org/wg12/files/LOM_1484_12_1_v1_Final_Draft.pdf).

LON-CAPA. (2007). The LON-CAPA Academic Consortium. Retrieved from [http://www.loncapa.org/presentations/LON-CAPA\\_Acad\\_Consortium.pdf](http://www.loncapa.org/presentations/LON-CAPA_Acad_Consortium.pdf).

Maloy, T. K. (8/14/2000). The IT learning curve expands. *Internetweek*, No 824, p 66.

Mateyaschuk, J. (6/15/1998). Career conundrum. *Information Week*, No 686, p 14.

McManus, D. & Snyder, C. (2003). Knowledge Management: The Role of Epps. *Journal of International Technology and Information Management*, 12(2), 17-28.

Pang, H.F. (3/20/2007). Workers need ability to learn throughout life. *Pittsburgh Post-Gazette*, Business News Section. Retrieved from <http://www.post-gazette.com/pg/07079/770716-334.stm>.

Polsani, P.R. (2/19/2003). Use and abuse of reusable learning objects. *Journal of Digital Information*, Article No. 164.

Seng, J. & Ying, M. (2004). A Genetic Algorithm Assisted Hybrid Approach to Web Information Integration. *Journal of International Technology and Information Management*, 13(1), 33-48.

Shackelford, R., McGettrick, A., Sloan, R., Topi, H., Davies, G., Kamali, R., Cross, J., Impagliazzo, J., LeBlanc, & R., Lunt, B. (2006). Computing curricula 2005: The overview report. *ACM SIGCSE Bulletin*, 38(1), 456-457.

U.S. Department of Labor. (2006). Bureau of Labor Statistics. Retrieved from <http://www.bls.gov/home.htm>.

Venkatraman, S. (2004). Web-Services – The Next Evolutionary Stage of E-Business. *Journal of International Technology and Information Management*, 13(2), 111-122.

Wang, J. (2005). Inference-Guiding for Intelligent Agents. *Journal of International Technology and Information Management*, 14(2), 98-108.