

Developing a GIS Certificate at the Community College Level

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ABSTRACT

This paper details the process through which the Certificate in GIS Technology was successfully established at Lexington Community College. Emphasis is placed upon the physical resources needed to construct a GIS certificate and the advantages of establishing a certificate in lieu of a full academic and/or technical degree. This paper will also make suggestions and recommendations as to how similar certificate programs may be developed at a minimal cost within diverse community college systems throughout the United States during an era of fiscal austerity.

Overview of Lexington Community College

Lexington Community College is unique amongst community colleges in North America in that it is physically and financially linked to a major research institution,¹ the University of Kentucky. Lexington Community College serves about 9,000 students each semester, of which two-thirds are full-time students. The majority of students attending Lexington Community College are seeking to transfer to the University of Kentucky (or another in-state four-year institution) following the completion of their core general education requirements. There are also several well-established technical two-year programs (nursing, radiography, environmental science technology, etc.) at Lexington Community College whose cumulative enrollment exceeds two thousand students.

¹ Lexington Community College joined the Kentucky Community and Technical College system on July 1, 2004, but will continue to maintain several components of its unique relationship with the University of Kentucky after the official transfer date.

The Certificate in GIS Technology at Lexington Community College

The Certificate in GIS Technology at Lexington Community College was approved in April 2003 and began operating in August 2003. The curriculum for the Certificate in GIS Technology consists of **twenty-four semester hours** of credit. GIS courses comprise nine hours of the program. The core courses in the Certificate in GIS Technology are:

- GIS 110 – Spatial Data Analysis and Map Interpretation
- GIS 120 – Introduction to Geographic Information Systems
- GIS 210 – Advanced Geographic Information Systems

The three courses in the GIS sequence must be taken in the order listed above. All students pursuing the certificate must take the prerequisite *Introduction to Computing* (CIS 105) prior to taking the first GIS course in the sequence.

Students must also take an additional six hours of credit from a field in which GIS may be applied. The Certificate in GIS Technology draws the vast majority of its students from Lexington Community College technical programs that possess a GIS component: Environmental Science Technology, Civil Engineering Technology, Architectural Technology and Computer Information Systems. Course pairings were designed for the Certificate in GIS Technology that also serve as technical electives for the student's chosen technical degree program. The GIS courses, in turn, serve as technical electives for the degree programs listed below. The arrangement, in short, enables students who are enrolled in varying technical programs to earn the Certificate in GIS Technology through the simple fulfillment of technical electives associated with their chosen technical degree program.

Students must also take a minimum of six (6) hours of General Education courses in order to receive a certificate in GIS Technology from Lexington Community College, unless otherwise noted on their academic transcript(s).

A complete list of the curriculum (including detailed course descriptions) can be found in Appendix A and at <http://www.uky.edu/LCC/GEO/GISCertificateAnnounced.html>

Certificate versus Degree Track and/or Program

There are multiple advantages to the establishment of a GIS certificate in lieu of the creation of a comprehensive degree program in GIS or the development of a specialized course track in GIS within the framework of an existing degree program. Lexington Community College elected to pursue the creation of the Certificate in GIS Technology over the creation of a technical degree or academic degree for the following primary reasons:

1. Employers generally view GIS as a technical skill as opposed to an academic discipline. A certificate, depending upon the parameters of the host institution, enables the course curriculum to be exclusively GIS courses or courses with a direct relationship to GIS. A full degree program does not allow such exclusivity, with the overwhelming majority of academic degrees possessing pre-major requirements that draw from across the spectrum of the university curriculum. A specialized course track within a degree also falls within the same umbrella of requirements – in order to fulfill the degree track, one must take all of the degree prerequisites, and hence, basic university curriculum courses.
2. The development of a degree program, be it a two-year technical program or four-year academic program, is an extremely arduous process and requires the development of curriculum for several courses which, if the degree is to be awarded, must be offered on a regular basis. This requires additional faculty hires that the participating institution may not have the financial resources to expend. A certificate will generally consist of fewer courses and can be taught by a small number of faculty who can be recruited from within the ranks of the existing faculty in other degree programs
3. Students wishing to acquire skills in GIS do not have the time or financial resources to invest in a two or four-year degree program and will find a certificate from an accredited academic institution an extremely attractive and marketable option.

Developing a GIS Certificate at the Community College Level

Assessment of community needs

The preliminary step in the development of a GIS certificate is to determine community needs. The rapid proliferation of GIS into all aspects of the public and private sector

signals that any assessment of the GIS needs of the local community should be conducted in an open-ended fashion that enables local entities to explain exactly what their current and projected GIS needs are and will be.

Lexington Community College distributed an extensive survey in 1997 to more than 700 public and private institutions throughout the central Kentucky region examining GIS usage throughout the Bluegrass. The results of this survey indicated that there was a strong demand and immediate need for GIS technicians in the Lexington-Fayette County MSMA and that a sizeable minority of establishments surveyed would send their employees to Lexington Community College for GIS training if it was available. Lexington Community College responded by creating the course *Introduction to GIS* (GIS 120), which debuted at the institution in August 1998.

Software requirements

The acquisition of software is an expensive commitment an institution must make if they are committed to developing a GIS certificate. Any educational institution should contact ESRI and inquire into the educational discounts on software they extend to eligible institutions.

Before any software purchase is made, ensure that your educational institution does not already have an existing site license established with ESRI. You may also check on-line at the following URL: www.esri.com/industries/university/site_license.html#topus

Lexington Community College is part of the University of Kentucky and, per the rules of the site-license that ESRI has with the University of Kentucky, is eligible to install any ESRI-produced software possessed by the University of Kentucky. Therefore, there were no software costs accrued through ESRI during the construction of the Certificate in GIS Technology.

Corporations are often willing to offer significant discounts to educational institutions. One should always inquire into whether any such promotional discounts are available before committing to the software purchase. Pathfinder Office software, used extensively in the GPS component of the GIS 110, curriculum, was, for example, purchased through a federal Perkins Grant at the discounted cost of \$2,500 through a local retailer. The retail cost for this software package was \$25,000 at the time of purchase in spring 2003, resulting in a 90% savings with the educational discount.

Hardware and space requirements

It is highly unlikely that a community college will be able to afford an independent laboratory exclusive to GIS. It is highly recommended that a community college utilize existing hardware resources when developing a certificate in GIS, for the hardware costs to develop a fully exclusive laboratory in GIS may easily exceed \$100,000 – far beyond the budget of the majority of public community colleges in times of budget reductions. The solution is to share a laboratory that is used for computer science or another technical degree field as opposed to sharing an “open” computer lab that is used for students to perform tasks such as word processing and Internet research. Computers located in “open” labs have a tendency to serve a more general student population, are more susceptible to abuse, deletion of programs and/or data, while computers that serve a specific student population tend to be better maintained and more responsibly operated. *It is absolutely essential to ensure that the GIS certificate has a permanent and standing reservation for specific time-blocks on a yearly basis.*

The Certificate in GIS Technology at Lexington Community College contains a GPS component. The purchase of GPS units can also become an expensive endeavor. Inquire other technical departments at your institution whether they have access to handheld GPS units. The Environmental Sciences Technology Program at Lexington Community College purchased a dozen rudimentary Garmin® handheld GPS units which they gladly share with the Certificate in GIS Technology. A recently acquired Perkins Grant has enabled Lexington Community College to purchase one Trimble® handheld GPS unit so

that students can acquire experience developing data dictionaries and uploading their data into ArcView GIS for analysis.

In the event your institution does not possess handheld GPS units, it is suggested you contact the retailers and inquire into whether they have any educational and/or bulk rate discounts. Garmin®, in particular, has a wide range of affordable GPS products, and if you have a nascent program it is recommended that you concentrate on purchasing quantity as opposed to GPS with sub-meter accuracy. The price for GPS equipment goes up dramatically as one moves from two to five meter accuracy to sub-meter accuracy. There is little reason for an educational institution to purchase GPS units with sub-meter accuracy for students with little to no GPS background.

A digitizing board is another suggested piece of hardware that a GIS lab should contain, as the vast majority of entry-level GIS positions require time dedicated to digitizing maps and data. A quality digitizing board can easily run in excess of \$15,000; therefore, it is best to contact local users of GIS equipment and inquire whether they have an older digitizing board they are planning to phase out. This board can be purchased at a significantly reduced rate, or for free, depending upon the organization. Many companies are more than happy to give away outdated equipment to educational institutions as they recognize the potential for reciprocation in the form of skilled graduates and partnerships with the educational institution.

The following is a list of suggested software and hardware requirements.

- 15 to 20 desktop (or laptop) PC with a minimum of 512 RAM speed
- LCD projector and screen
- ESRI ArcView 3.3 or 8.x
- digitizing board
- 5 to 10 handheld GPS receivers

Faculty and Staffing Requirements

The size of the GIS certificate will determine the number of faculty and staff needed to maintain a quality program. The average full-time faculty member at a community

college teaches four courses during a semester, though this figure varies greatly from institution to institution (Lexington Community College full-time faculty instruct five courses a semester). It is likely that a minimum of one full-time faculty member will be needed for the instruction and maintenance of courses taught in the program. The Certificate in GIS Technology has only three GIS courses that are offered on a fall/fall – spring basis each year. A single faculty member in geography is responsible for the instruction of the two 100 level GIS courses; an adjunct faculty member is utilized for the instruction of the Advanced Topics in GIS (GIS 210) course. The remainder of the courses required to earn the Certificate in GIS Technology are taught by faculty from various technical programs. These supplemental courses, which are required for graduation from the respective technical programs that offer them, do not incur any additional faculty workload, for they will be taught regardless of the existence of the Certificate in GIS Technology.

It is highly suggested that new hires in programs associated with GIS be informed that their official position description may require teaching a course in the GIS certificate track. Advertisement for vacancies should reflect this responsibility in the official position description.

Establishment of Articulation Agreements

During the formative process of the Certificate in GIS Technology several articulation agreements were established with technical programs at Lexington Community College: Computer Information Systems, Environmental Sciences Technology and Civil Engineering Technology. The curriculum for the Certificate in GIS Technology incorporates course pairings from each of these respective programs that may be used as technical electives. These respective programs, in return, list GIS courses as technical electives for their degree programs. The flexibility of the curriculum of the certificate enables students of various Lexington Community College technical programs to take electives that fulfill degree requirements as well as certificate requirements.

An articulation agreement was signed in January 2003 with Western Kentucky University. Western Kentucky University has an extensive GIS track in their undergraduate degree in geography that will enable students who have taken the core courses of the Certificate in GIS Technology at Lexington Community College to receive credit for specific upper-level undergraduate courses in the event they wish to pursue a Bachelor of Arts and Western Kentucky University. Additional articulation agreements are being explored with the undergraduate geography programs at Murray State University and Eastern Kentucky University.

Gauging Administrative and Faculty Commitment to a GIS Certificate

It is essential to gauge the long-term ambitions of the community college before embarking upon the creation of a certificate in GIS. The following questions must be addressed:

1. What is the stance by senior administrative officials at the community college in regards to certificates? There are some community colleges that offer a host of certificates; others do not offer any. If the institution does not offer any certificates, investigate whether there are any rules in the community college charter that prohibit certificates or whether administration is resistant to the presence of certificates.
2. What existing resources are available at the community college that can be earmarked towards the formation of a GIS certificate? How receptive are other departments to the sharing of resources, time and space for a GIS certificate?
3. How will the formation of the certificate impact other existing degree programs? A certificate that has the potential to siphon away students from other degree programs will be met with natural resistance from other faculty, while a certificate that has been developed to compliment other degree programs will be promoted by faculty keen on increasing their own program enrollment figures.

Obstacles to the Creation of the Certificate in GIS Technology at LCC

The challenges faced in creating the Certificate in GIS Technology at Lexington Community College largely centered upon lack of space for the housing of GIS courses. Lexington Community College has seen its enrollment more than double since 1995 while operating within the same amount of space. The securing of a single computer classroom for a twice a week 75-minute time block for both the fall and spring academic

terms proved to be an extremely difficult task that required a great deal of compromise with other academic and technical divisions within the community college, all of whom were short on space. The community college also had to accept a loss in tuition dollars by earmarking a classroom for GIS, as the smaller class size (maximum twenty students) that is essential to maintain a quality GIS course meant the university had to sacrifice the additional tuition revenue had the classroom been utilized for a general education course, in which thirty-five students could be enrolled.

The solution to the space problem was addressed by creating a certificate that was largely comprised of courses offered by other technical programs that already had block reservations on specific classrooms at specific times of the day and week. The GIS courses are exclusively scheduled in the evening in order to avoid peak classroom demand time during the day. The student population that enrolls in GIS courses at Lexington Community College is, moreover, one that prefers evening courses, as the vast majority are non-traditional students who are employed full-time during normal business hours.

An oft-overlooked relationship that is critical to ensuring a quality GIS certificate is to develop an excellent rapport with college staff employed in computer maintenance and media technology. These individuals are instrumental in ensuring the proper software is installed and running properly on machines and troubleshoot equipment on a regular basis. Anyone who has ever relied heavily on multimedia equipment in the classroom knows full well that technical snafus can and will happen. The bottom line is to ensure good relations with technical staff personnel – they can make or break your program.

Conclusion

The proliferation of GIS in both the public and private sector has spurred nationwide growth of GIS programs in community colleges. Many institutions have opted to offer a certificate in GIS in lieu of a technical degree. A lessened student time commitment, a smaller budget and increased flexibility in the development of curriculum are all

significant factors in electing to develop a certificate as opposed to a more comprehensive degree program in GIS.

The Lexington Community College experience in the development of their Certificate in GIS Technology addressed all of these above factors. The conclusion was made that the student population who would enroll in GIS courses would largely be drawn from those enrolled in other two-year technical degree programs at Lexington Community College. The development of a similar technical degree program would place it in direct competition for students and college resources and would not have gained widespread support from existing technical programs. The Certificate in GIS Technology was designed to compliment existing degree programs by sharing common course electives, and hence, students. The utilization of pre-existing resources on the campus of Lexington Community College coupled with the community college's unique relationship with the University of Kentucky that enables it to access the ESRI site license, ensured that start-up costs for the Certificate in GIS Technology were held to an absolute minimal, thereby making it a very attractive to governing bodies at Lexington Community College which ratified it in April 2003.

Lack of space continues to be the primary issue of concern for the Certificate in GIS Technology. The enrollment figures in our GIS courses continue to grow. Our GIS courses are always waitlisted, and many students complain that they cannot pursue the Certificate in GIS Technology because each course in the GIS track is only offered once a year and they are not willing to delay their entry into the job market in order to complete the certificate if they already have their technical degree in hand.

Appendix A – Outline of the Certificate in GIS Technology and Course Descriptions

Certificate Requirements:

All students enrolled at Lexington Community College are eligible to pursue the GIS Technology Certificate. There is no application to enroll in the certificate, but it is suggested that if you elect to pursue the certificate that you inform the coordinator of the GIS Certificate as well as your technical advisor and the chair of your technical degree

program. The curriculum is tailored to those enrolled in the following technical degree programs: Architectural Technology, Civil Engineering, Computer Information Systems and Environmental Science Technology. The acquisition of a two-year technical degree coupled with a Certificate in GIS Technology will make a graduate more marketable in his/her respective field. Those pursuing a B.A. or B.S. degree in geography will also find the curriculum tailored to their respective degree program. **The GIS Technology Certificate requires the completion of twenty-four (24) hours of coursework.** Non-certificate seeking students are free to take courses in GIS. **All students pursuing the certificate must take the following four core courses:**

- CIS 105 – Introduction to Computing
- GIS 110 – Spatial Data Analysis and Map Interpretation
- GIS 120 – Introduction to Geographic Information Systems
- GIS 210 – Advanced Geographic Information Systems

Students must complete one of the following related field course pairings listed below. The student may not complete the requirement by selecting courses from different pairs. It is highly recommended that the student select the course pairing that doubles as requirements for their technical degree and/or academic program.

Eligible Course Pairings for the Certificate in GIS Technology

- Earth's Physical Environment (GEO 130) *and/or* Pollution, Natural Hazards and Environmental Management (GEO 210) *and/or* Introduction to Planning (GEO 285)
- Fundamentals of Hydrological Geology (EST 160) *and* Fundamentals of Solid Waste Management (EST 250)
- Visual Basic I (CIS 148) *and* Visual Basic II (CIS 248)
- Introduction to Computer-Aided Design (CAD 100) *and* Intermediate Computer-Aided Design (CAD 200)
- Computer Aided Drafting I (ACH 185) *and* Computer Aided Drafting II (ACH 285) *or* Computer 3-D Modeling (ACH 298)
- Introduction to Surveying (CE 211) *and* Intermediate Surveying (CET 220)

Students must also take a minimum of six (6) hours of General Education courses in order to receive a certificate in GIS Technology from Lexington Community College, unless otherwise noted on their academic transcript(s).

Students who are not wishing to earn the GIS Technology Certificate are welcome to enroll in any GIS course provided they meet the prerequisite(s) of the desired course.

Recommended Track for the Certificate in GIS Technology

Fall Semester I (9 credit hours)

- GIS 110 (3)
- CIS 105 (3)
- Any General Education Course (3)

Spring Semester I (9 credit hours)

- GIS 120 (3)
- Any General Education Course (3)
- Related Field (see above list) (3)

Fall Semester II (6 credit hours)

- GIS 210 – Advanced Topics in GIS (3)
- Related Field (see above list) (3)

TOTAL CREDIT HOURS: 24

Appendix B -- Course Descriptions for the Certificate in GIS Technology

ACH 185 – Computer Graphics I (3 hours) – Students learn how computer hardware and software are used in preparing architectural documents. Lecture: 2 hours; Laboratory: 3 hours.

ACH 285 – Computer-Aided Drafting II (3 hours) – Students learn how to modify selected computer aided drafting software to enhance construction document production. Integration of other software will also be discussed.

ACH 298 – Computer 3D Modeling (3 hours) – Students learn how computer hardware and software are used in preparing 3D architectural drawings and client-oriented presentations.

CAD 100 – Introduction to Computer-Aided Design (3 hours) – An emphasis will be placed on techniques of computer drafting; construction of straight and curved lines; orthographic and axonometric views and sections; dimensions, tolerances, and notes; as well as an introduction to the terminology associated with CAD. Basic computer operations involving move, copy, delete and save are included, along with drawing manipulation involving translation, rotation, zooming, panning, and windowing.

CAD 200 – Intermediate Computer-Aided Design (3 hours) – Students will develop familiarity with standard symbols associated with one or more application areas. Competency will be developed in advanced techniques of drafting, including complex curves, layers, and the production of three-dimensional wire models - with and without hidden lines. The students also will learn to calculate lengths and areas associated with the drawings, and will write simple programs in an appropriate high-level language to interface with the existing CAD software.

CE 211 – Introduction to Surveying (4 hours) – A comprehensive course in the art and science of surveying as applied to civil engineering, including the use and care of surveying instruments; measurement of horizontal and vertical distances, angles and directions; collection of ground and underground data for the design and layout of roads, buildings, various mineral workings and

other structures; and some aspects of the precise determination of position and direction for survey control.

CET 220 – Intermediate Surveying (4 hours) – The course will include the application of surveying practices for route surveying for highways, construction staking, and topographic surveys. Students will perform deed research and evaluation, convert outdated deed descriptions into current measurements, and prepare record plats.

CIS 105 – Introduction to Computing (3 hours) – An overview of computer information systems. Concepts include terminology, computer hardware, software, and networks as well as the impact of computers on society, ethical issues in computing, and trends in information processing. Students use a microcomputer with systems software and applications software, including a word processor, electronic spreadsheet, database management system, and web page editor to process data and present useful information.

CIS 148 – Visual Basic I (3 hours) – Students design, code, test, and execute programs on this Level I programming language. Topics also include menus, dialogue boxes, child window controls (push buttons, radio buttons), the graphical user interface, mouse input, fonts, and printing.

CIS 248 – Visual Basic II (3 hours) – Students build applications using Visual Basic, a Level II programming language. Application development is introduced with an emphasis on application design, record-handling routines, and database engine operations. Students work with objects from Microsoft Office, create ActiveX documents, and build Internet applications with these documents.

EST 160 – Fundamentals of Hydrological Geology (3 hours) – This course provides an introduction to geology and hydrology with an emphasis on understanding natural processes and the effects of human activities. Major topics covered include: plate tectonics; formation and classification of rocks and minerals; the processes affecting the hydrologic cycle; soil formation and classification; subsurface geology and groundwater movement; stream formation and flow; floods; and human impacts to stream hydrology and morphology.

EST 250 – Fundamentals of Solid Waste Management (3 hours) – This course examines methods of managing solid and hazardous waste, with an emphasis on pollution prevention. Topics covered include relevant legislation, recycling, incineration, landfill operations, management of radioactive waste, remediation of waste sites and site worker health and safety.

GEO 130 – Earth's Physical Environment (3 hours) – A course exploring the fundamental characteristics of Earth's physical environment. Emphasis is placed on identifying interrelationships between atmospheric processes involving energy, pressure, and moisture, weather and climate, and terrestrial processes of vegetative biomes, soils, and landscape formation and change.

GEO 210 – Pollution, Natural Hazards and Environmental Management (3 hours) – An introduction to environmental systems such as weather and climate, vegetation, landforms and soils, and how the quality of these systems is modified by human use. Resource issues discussed include: atmospheric pollution and global warming; groundwater, flooding, and flood plain management; volcanic activity and earthquakes; and biospheric processes associated with deforestation and lake eutrophication. Case studies based upon important environmental problems illustrate how human activity and environmental systems interrelate.

GEO 285 – Introduction to Planning (3 hours) – An introduction to the history, purpose, and objectives of planning with emphasis on urban and regional planning, planning processes, techniques, and legislation.

GIS 110 -- Spatial Data Analysis and Map Interpretation (3 hours) – This course is an introduction to spatial analysis and the interpretation of map data. The course will introduce remote sensing techniques, GPS, the interpretation of remotely sensed imagery for environmental, commercial and/or demographic purposes, and the applications of GIS in both the public and private sector. Students will receive a cursory introduction to GIS software.

GIS 120 -- Introduction to Geographic Information Systems (3 hours) – This course, a continuation of GIS 110, is a comprehensive survey of the fundamental concepts of GIS. The course will cover the basic operating systems of widely used GIS software, including (but not limited to) the use of graphic user interface, common theme operations, introductory scripts, manipulation of tables, the creation and editing of shapefiles and charts and layouts, and geocoding. This course is designed for those with little to no experience with GIS who are exploring career opportunities in the field.

GIS 210 – Advanced Geographic Information Systems (3 hours) – This course, a continuation of GIS 120, will explore advanced topics in GIS. The course will teach students how to import foreign databases into a GIS, advanced theme operations, extensive use with scripts, introductory programming with both Avenue and Visual Basic for GIS, and how to incorporate remotely sensed imagery into GIS.

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