<u>**Fitchburg State Geographic Science and Technology External Program Review 2020**</u>

William Hansen
Worcester State University Department of Earth Environment and Physics
December 1, 2020

Introduction

The following report resulted from my examination of the Geographic Science and Technology Self Study review and my visit to Fitchburg State University which took place on October 16, 2020. During the visit I met with the Dean of Health and Natural Sciences Meg Hoey, Jackie Kramer, Dean of the Amelia V. Gallucci-Cirio Library and Lori Steckervetz the library liaison for the department. This was followed by a meeting with department faculty members Jane Huang, Reid Parsons, Elyse Clark and Jiang Yu. In the afternoon I met with students in the department; Caroline Anderson, Robbie Carpenter, Sean Krieger and Teigan Weismann and then the Provost Alberto Cardelle before wrapping up the visit with a tour of the classrooms and offices and a discussion with the chair of the department Elizabeth Gordon.

Program Overview and Vision

Department Overview

The Geographic Science and Technology program is one of three majors offered by the Department of Earth and Geographic Sciences. In addition to this major the department offers three minors in this program area; Geographic Information Systems, Geographic Science and Technology and GIS Crime Mapping. The other programs offered by the department but not assessed by this review are a major in Environmental and Earth Science and a brand-new interdisciplinary major in Environmental Public Health. In addition, the department offers a minor in Earth Science as well as offering physics courses for department majors and other programs such as Applied Science and Technology, Biology, Chemistry, Applied Mathematics and Engineering Technology.

As of Fall 2019 the department had six full time faculty members; three in earth science, two in physics and one in geographic science. This last item is a concern as the Geographic Science and Technology program is heavily dependent on that one faculty member, Dr. Jane Huang. Specific issues related to this will be identified in this review as it is a significant issue for the program.

The department saw encouraging growth in the time period after the previous self-study, the numbers increased from 24 majors to 47 with 10 of those in the Geographic Science and Technology program. New courses were added to better reflect trends in the discipline and minors that would work well with and support other major programs were developed. In addition, a new major program Environmental Public Health was established as of Fall 2019. This program developed out of a collaboration between Dr. Huang and Dr. Debbie Benes of the Nursing program. It presents new opportunities for students but an additional time investment for Dr. Huang.

Mission and Objectives

Students in the Earth and Geographic Sciences Department will develop a rich understanding of Earth's natural and social systems by cultivating analytical skills in the field, classroom, and laboratory environments. Programs in the department are designed to allow students to explore their interests with

experiences that bring together theory and application, contribute to scholarly development, and prepare students for a range of career pathways.

The mission statement effectively captures the essence of Earth and Geographic inquiry in examining the intersection of "natural and social systems" and highlighting the program's fundamental strength of providing students with the tools and guidance to analyze these issues in diverse settings inside and outside the classroom. In interviews with students it was this hands-on approach and the incorporation of a variety of analytical and instrumental techniques that the students felt made this program stand out from other programs at Fitchburg State that they were familiar with.

The Department objectives are succinct and highlight the importance of addressing the environmental challenges facing society and the critical role that the disciplines taught and researched by the department play in solving these issues. The vision also identifies the strong local connection of a State University in serving the local community and region with the expertise of the faculty and the effort of the students.

Geographic Science and Technology Major Program Objective's do not include a technology component which is a shortfall. The University Mission Statement incudes curriculum technology which would make for a nice fit and alignment with the increasing technology driven economy. Student learning outcomes include SLO 5 Geospatial technical skills. The Program's SLO assessment plan includes the assessment of geospatial technical skills. In particular this skill has applicability across disciplines, trends in the discipline have made it more accessible and is a means for the program to expand by attracting more students and serving as a resource to the community.

Recommendation

- Consider adding a technology objective to the Major Program Objective to align with the defined Student Learning Outcome and the University Mission Statement.

Program Overview

This review focuses on the Geographic Science and Technology (GST) major program. The program was formerly the Geography program, the change to GST reflected a trend common nationwide to make Geospatial technologies the core of a geography program which incorporates the traditional mix of physical, cultural and regional geography. The physical geography component of the curriculum is supported by full time faculty. The cultural/regional component is supported by adjuncts which is a concern for the program. The department has requested a new tenure track position in cultural geography and GIS to provide additional support for the GST program and to teach the cultural/regional component of the curriculum. The self-study notes that this request has been made each year since the prior self-study completed in Spring 2015 but has not yet been approved. The program is in the typical quandary of needed to attract more students to get additional resources, yet needing additional resources to attract more students.

The curriculum of the programs provides students with a basic introduction to Geography with 1000 level courses on Earth System Science and Human Geography. Students take 4 courses from the Geospatial curriculum; Introduction to Geospatial Technologies, Computer Cartography, Geographic Information Systems or Geographic Information Systems II and Remote Sensing. Students complete the major by taking 6 additional electives from 19 courses including a maximum of 2 courses in Economics or Political Science. Students opting for a Geospatial heavy course load can take an additional three courses on GIS for Criminal Justice, Web GIS and either GIS or GIS 2. Internships can also be taken as

upper level electives, students can take 3, 6 or 12 credit internship experiences. The program has been very successful in placing students in internships in the area in a variety of settings and agencies. In addition to major courses students are required to take 2 cognate classes, CSC 1500 – Computer Science 1 and MATH 1300 – Precalculus or a higher-level math course.

The Department offers 3 minors; Geographic Science and Technology (GST), Geographic Information System (GIS) and GIS Crime Mapping and Analysis. The GIS minor was added in the Fall of 2015, the course options are interdisciplinary, encompassing Geographic Science and Technology, Computer Science and Industrial Technology. By 2019 five students who were GST or EES majors graduated with this minor. The other new minor is the GIS Crime Mapping and Analysis which developed out of the special topics course co-taught by Jane Huang and Marcel Beausoleil in Behavior Sciences in Fall 2017. The minor was approved in 2018, it is intended for GST and Criminal Justice students to provide them with the skills to "explore the relationship between crime and other types of datasets".

The curriculum of coursework, major and minor requirements and courses is an impressive collection for a small department with only one full time GIS faculty member. It was created and continues to expand and evolve through the hard work of faculty, as well as students, and the connections created with other programs as well as local and regional community connections. One of the major issues faced by the program is the heavy reliance on the one GIS faculty member. The concerns over this include: offering the needed courses in a timely manner that would allow students coming into the major or minor to complete the program, attracting new majors through the introductory classes ideally taught by full time faculty, providing internships and research opportunities for students, increasing marketing efforts and continuing to evolve the program. A concern over the reliance on one faculty member is the diversity of courses that Jane Huang needs to teach, often four preps per semester in addition to supervising a large number of GIS related internship opportunities.

Major Minor Programs

The Geospatial programs and course offerings have increased over time and the self-study facilitates a review of the program's offerings and course sequencing. In the online catalog the Geographic Science and Technology (GST) minor does not have a description which would lay out the logic and allow students (and program reviewers) to determine the purpose and target audience. It is essentially a remnant Geography minor which student can complete taking only one geospatial technologies class, computer cartography. Given that the department change the Geography major to a more technical program and it would be more consistent to increase the technical requirements of the minor. The Geographic Information System (GIS) minor clearly lays out the purpose and, as identified in the self-study, is clearly designed to enhance students' technical skills through the Computer Science component as well as the Geospatial technologies component. Is it worth having both the GIS and GST minor? The GST minor seems to be geared to students in other sciences and social and behavioral sciences while the GIS minor is for students in EES and more technical programs such as Computer Science or Engineering Technologies. Neither of these minors has GS 2400 as a required class (see below). The GIS minor could have GEOG 2400 replace CSC 1550 as a required course with CSC 1550 as an elective. Students from a science or social science program wanting a GIS minor would have taken courses that cover many of the concepts from either GEOG 1000 or GEOG 1100.

The core program the GST major, has some overlap with the EES program which makes sense and is necessary to maintain it given there is one faculty member. However, there are some steps which could be taken to further separate it. The description given for the course Geographic Information System 2 essentially represents the culmination of Geographic Science and Technology curriculum. Students draw on their geospatial skill set as well as their academic foundation and understanding of

their community and world to develop GIS applications to solve real world problems. If this is what distinguishes it from GEOG 4000 (and not ArcPro vs ArcGIS) then it is essential that this be a required course, it is the de facto capstone class for the program. The current set of required classes with the option of students taking Geographic Information Systems OR Geographic Information Systems 2 should be addressed. One would clearly think that GIS would need to be taken before GIS 2 and yet GIS 2 can be taken after only Urban Geography or a programming class. This could make for some interesting and even quite effective student pairings to complete projects but is a burden on the instructor to manage a one room school house of GIS.

Courses

As a program develops, courses are added to the curriculum and requirements are updated. Situations change over time so a program review provides the opportunity to examine the titling, numbering, sequencing and description of courses. The course GEOG 2400 Introduction to Geospatial Technologies is identified as "A gateway course to theories, skills and techniques of geospatial technologies". This course is required for the GST major, required for the GIS Crime Mapping and Analysis minor but is only an elective for the GST minor and GIS minor. Making this class a requirement across all programs and emphasizing it as a general education course could allow two sections to be offered per semester. With the new general education curriculum, the course could be reconfigured as a lab course emphasizing the inquiry and analysis component. This would reduce the number of different courses taught by Dr. Huang and make the course the essential gateway. As such this course could be used as a recruiting vehicle to the discipline within Fitchburg State and would be an ideal class for a co-education class taught for High School students. ESRI software is provided to secondary schools free of change so this course could even be taught on site at local schools as a grant funded recruiting activity.

The sequencing of the required and elective courses which students follow demonstrate a progression in numbering but not in terms of pre-requisites. This is not uncommon in a developing program where the number of majors is small and students are recruited from a number of classes. However, it presents an issue for students who can be confused by a seeming lack of structure and logical progression. In addition, it presents a concern for the instructor of these courses which would have students at different levels of proficiency in the technology and skill set needed for success, as previously mentioned. Course numbering has always been a grey area as courses are developed, go inactive or retired, but is still looked at by students as representing the difficulty they will encounter and the preparation needed to attempt the course. GEOG 4000 may be taken by a student who has only take a computer science course on spreadsheets. GEOG 4003 which as mentioned represents the culmination of the program has the exact same pre-requisites except for a slightly more advanced computer science course but no GEOG 4000 with which it shares a name (except for the 2 part). As part of the overall assessment strategy the components of the geospatial curriculum which introduce, develop and master concepts should be examined and the curriculum and pre-requisites adjusted.

The department is also considering a capstone class requirement. Such a class provides students with the opportunity to reflect on their college career and assemble and rework materials for a portfolio. They are often used to have students hone skills and develop resumes to best represent themselves in job interviews or graduate school applications. This is a recommended practice and as the department works toward this goal GEOG 4003 could be used to try out portfolio building for GIS student work.

Another area to address is the course descriptions. As university catalogs evolve from print to web it makes the catalog more accessible to prospective students in a format that the current generation of students (and even reviewers) can easily navigate. Consistency is therefore important and is essentially a component of marketing. One can clearly see the story of the evolution of the discipline as

well as changes in the toolset which should probably be told in a more generic manner (GIS is PC-based!). As word counts for catalog descriptions increase, newer courses have a more robust description while older courses look terse by comparison. This process often requires a run through the governance process but is a worthwhile activity.

Recommendations

- The department should continue to request a tenure track position in the area of human geography and GIS.
- The department should consider making the course GEOG 2400 the entry point for the program and increase the offerings of it to attract students to the program.
- The department should consider establishing a more linear path through the geospatial courses with the sequence of GEOG 2400, GEOG 4000 and GEOG 4003 in that order.
- The department should consider renumbering courses and updating course descriptions to convey a logical sequence of increasing complexity and expected proficiency.
- The department should explore the Capstone course idea though faculty discussion and the addition of portfolio and synthesis building activities in upper level classes..

Enrollment and Recruitment

Recruiting more students is a major goal for the Earth and Geographic Sciences Department and in particular for the Geographic Science and Technology program. A number of the recommendations from the Spring 2015 program review were put into action to address this. The department has seen an increase in the number of majors in the EES program (18 – 37) as well as an increase in the number GST major from 6 students to 11 during the time period AY14 to AY 18. The increase is credited to improvements in marketing including a name change to more accurately reflect the curriculum and focus of the program. The new minor program on GIS Crime Mapping and Analysis is expected to draw additional students from the Criminal Justice program. Students from outside the department also take GEOG courses to satisfy the General Education requirement which provides an opportunity to recruit majors.   The department will be examining the Gen Ed curriculum and will need to make modifications to courses to continue these offerings. This presents an opportunity to draw more students to a smaller number of gateway courses.

The department has improved the website and created a Facebook page as well as an Instagram site to reach students on social media. The department chair meets with admissions staff to work on strategies and the department participates in open house programs as well as outreach such as Early College and Sizer programs. The admissions office created a recruitment video which included students from the program and other students have been featured in university publications and local media. Dr. Huang has conducted many outreach activities in the local community including trail mapping, neighborhood analysis and the development of Web Mapping projects. These activities help raise awareness of the program and the program should try to expand these activities and create more connections to local schools, both secondary schools and community colleges.

During the site visit one of the items discussed with students was how they learned about the program. Only one arrived at Fitchburg intending to be a major, this student was a transfer from Mount Wachusett CC. One student from Lunenburg, a town adjacent to Fitchburg, indicated that they were unaware of the program even though they had a strong interest in the environment in High School. In whatever manner they arrived, the students felt very strongly that the program was more supportive of students and provided more in the way of hands on opportunities to use equipment and technology than

other programs they were aware of at Fitchburg State through their friends.   This is one of the strengths of the program which needs to highlighted as much as possible.

Within the University the department could increase its exposure through self-promotion around discipline events such as Geoscience week (No student left indoors!) or Geography Awareness week. National academic groups as well as vendors such as ESRI provide free materials to such as posters or buttons to distribute. Other interdisciplinary activities such as developing a University wide Sustainability Awareness event would allow the program to be at the forefront of a college wide event. Such an event could include holding a teach-in on sustainability and inviting local community agencies and advocates. Many other disciplines on the campus includes climate change and sustainability in some of its curriculum and would be likely be enthusiastic participants in such an event. The University itself could highlight its own sustainability program and efforts to reduce its carbon footprint and make the campus more sustainable. The program has successfully partnered with other departments with the GIS Crime Mapping minor and could possibly replicated this with other programs such as Biology and or Engineering Technology.

Other areas of promotion would be to increase outreach to local schools through activities and possible co-educational classes such as early college programs. The North Central Early College Academy already offers department courses in Physics. The course Introduction to Geospatial Technologies would be perfect for such an activity and if funding were available it could be taught onsite at local High Schools. In the short term, more outreach to local high schools could highlight the program and attract students. A model followed by other programs would be to have students in GIS 2 develop GIS activities and give the lesson in a local school. Developing curriculum that follows the State Frameworks and highlights a local issue would help GST majors solidify their understanding of the concepts by teaching them and would assist local schools in broadening opportunities. If the department were to develop an Unmanned Aerial Vehicle (UAV) or drone program this would be another activity to conduct with local schools.

Connections to Community Colleges also help with recruiting. The department has an articulation agreement for the EES program with Mount Wachusett CC. Both Mount Wachusett and Quinsigamond have similar programs to draw students from and each have introduced a GIS course to these programs. By establishing a formal articulation pathway, it helps to address issues such as math competencies and general education requirements and create a doable two-year plan for students earning a BS after an Associate's degree.

Recommendations

- Raise awareness of the program within Fitchburg State though the development of activities highlighting the technologies and applications used in the curriculum.
- Expand community outreach by cooperative projects with local groups through the Geospatial expertise of the faculty and students.
- Explore participation in the Early College program with the Introduction to Geospatial Technologies and look for funding opportunities to allow additional outreach.
- Leverage the enthusiastic department students to develop outreach activities with schools and community youth groups.

Student Opportunities

Interviews with the students and a review of the self study demonstrate that once a student is part of the department they have abundant opportunities for success and the support that is needed. The faculty are dedicated to student success and with the number of faculty and majors there is ample

opportunity for interaction and for students to explore the discipline. Students highlighted the opportunities to interact with faculty and to gain experience with equipment and technology as well as field activities as the strength of the program. In particular they highlighted the Nashua River project as a fabulous learning experience which also provided the opportunity to interact with community and government officials. Students expressed a desire for longer laboratory and field activities to take a deeper dive into the use of equipment and technology. This would further support possible changes to courses to adjust to changes in the general education curriculum. GEOG 2400 for example could be turned into a lab course which would allow for more field activities for GPS data gathering.

The internship opportunities that students have in GIS is very impressive and even more so when considering that there is one faculty member supporting these activities. 17 of the 30 student internships based in the department during the study time period were in GST at 11 different agencies/locations. Given more support, internships could be a required component of the program providing students with invaluable experiences.

Additional experience is given to students through the peer educator program in which advanced students assist instructors in a class in working with students and helping them with geospatial exercises. Students also participate in the Fitchburg State Undergraduate Research Conference. The department is developing study abroad opportunities although with the current Covid-19 situation the planned Spring 2022 trip would likely be delayed.

Recommendations

- The department should consider making some geospatial courses lab courses to increase field opportunities and recruit gen ed students.
- The department should continue to explore other educational opportunities such as study abroad.

Scholarship and Community Service

The department has participated in a number of scholarly and community service activities and has been very effective at providing opportunities for students to participate in these. The GST program in particular has done an impressive number of projects in the local community lending the expertise of the program to addressing community issues. Dr. Huang in a co-investigator on a grant project with the Fitchburg State Criminal Justice program and the District Attorney's Office to examine the opioid epidemic. Numerous community service projects ranging from trail mapping to web site hosting were done in cooperation with local non-profit agencies and municipal. Overall this is an impressive collection of projects. A concern expressed by Academic Affairs is that the program should look to use these opportunities to generate revenue if possible to support the program and university.   This would support one of the goals of the Universities' Strategic Plan to enhance fiscal growth. Additional partnerships with the Crocker Center could work toward this goal using the expertise of the program and create additional partnerships. The GST program can also look to work with the Center for Professional Studies to develop certification programs in the area of GIS, Web GIS and down the road, drone services. These certification programs would require additional resources in the form of a dedicated lab tech to support professional education courses.

Recommendations

- The program should continue to work with the Crocker Center to develop community service opportunities for faculty and students.
- The program could start to plan for developing certification programs in the area of Geospatial tools.

Facilities and Equipment

Library Resources

The Fitchburg State Library provides adequate support for the program through the collection and databases. The library recently added the JSTOR database as well as eBooks which are a more cost-effective strategy for adding materials. The Library cites a collection of over 14,000 Earth and Geographic Sciences related titles and given the current pandemic the increase in electronic resources is a huge advantage. The library provides in-class support upon request. In addition, the library supports the development of Open Education Resource (OER) materials for students. OER materials save the students the cost of textbooks which is particularly important for the demographic of State University students. Dr. Yu one of the Physics professors uses OER materials in her physics courses. Using these materials puts an additional burden on instructors but allows curriculum to be customized to the class and geographic setting.

In the department assessment of written and oral expression the results show that students struggle with information literacy especially in the area of "properly citing sources and using appropriate information sources". The department has identified this as an area of concern. During the library visit and discussion during the site visit the library has dedicated staff to the science discipline to work with faculty in their courses and improve this. The department has indicated in the self study that some, but not all, incorporate library instruction and resources in their courses.

Recommendation

- The Department should work with the library staff to develop a strategy to address the information literacy issue.

Department Facilities and Equipment

The department has adequate classroom and lab resources to support education and research. There is a large computer lab for GIS classes with overflow areas so department students can quietly work on projects during class. The campus is situated close to open space areas for field trips and there are vans available for transportation. The time available for field trips could be improved simply through scheduling and perhaps reconfiguring courses to have a distinct lab section to add time for these activities. The department has adequate field equipment for class use.

One limitation on equipment is the dramatic growth in GIS software products, equipment and platforms that create a situation in which one faculty member cannot possibly be proficient in all the modalities of GIS. Given the complexity of the discipline it would make sense for the department to hire a dedicated GIS lab tech to work with Dr. Huang and support the program. This position could start out as a part time contract position for a modest investment. Graduating students as well as graduate students in other Geoscience programs would find such a position attractive. The lab tech would maintain the software and hardware and would be essential to developing an ArcGIS Online platform which would allow the deployment of smart-phone based GPS data collection applications using ArcGIS Collector customized to department field activities. This could help to integrate GIS into any department course which collects field data. In addition, the department would not need to maintain GPS units for field activities.

The lab tech could also support the development and maintenance of Open Educational Materials for Geospatial classes. These would then be available to support co-educational activities and the software is already free for secondary schools making these activities more cost effective. The department is looking to develop a drone program. Drones have developed into standard equipment for

Geoscience programs for use in field activities from mapping to habitat assessment and surveying. Familiarity in their use is an essential skill for graduating student. Cross programmatic connections could be established with Engineering Technology, Computer Science, Communication and Biology. It could serve the University with video promotions and could be brought to recruitment events.

It would be important to have an additional person proficient in the use of this technology given the FAA standards for licensing if the drone is used by commercial or government entities. The lab tech would provide support for outreach with local schools through hands-on demonstration of equipment, online mapping and use of the drone.

Recommendations

- The department should consider the development of OER materials for the Geospatial courses.
- The department should explore hiring a dedicated GIS laboratory technician to support the program in terms of software, hardware and an expansion of equipment used such as Arc Collector and drones.

Program Outcomes and Assessment

The program has a well-developed set of Student Learning Outcomes that are appropriate, clear and assessable. The assessment measures are well developed and implemented. The outcomes include competencies that overlap the EES program and some that are specific to Geospatial skills. Students have shown improvements over the previous period of study and this is credited to curriculum changes made. In addition, the improvement is also credited to the development of the peer educator program which has been used in geospatial courses for the past three years.

With the implementation of the new General Education curriculum the department needs to examine how the changes will affect enrollment. As a small department in a discipline which covers a variety of distinct ways of looking at and studying the world the general education curriculum offers an opportunity to attract students who may not realize what Geography is. This lack of awareness is exacerbated by the secondary school curriculum in Massachusetts which does not cover geography after middle school and only includes Environmental Science in limited offerings as an AP class.

Another initiative which could assist the program is the development of an Advisory Board. Given the nature of the field and the ever-changing technology a committee drawn from local government agencies, consulting companies, conservation managers and former students would be a useful sounding board. In addition, the advisory board could assist in preparing students to enter the job market through mock interviews and resume preparation especially if the department adopts a capstone class. This is a function that should be supported by academic affairs but is a modest investment that would involve a once or twice a year dinner. A carefully chosen board can become "friends of the program" and expand the network of collaboration within the community and provide assistance with developing opportunities to leverage expertise to obtain outside revenue.

Recommendations

- The department should examine the Geospatial curriculum to map out competencies and address the information literacy issue through collaboration with the library.
- The department should consider making GEOG 2400 Introduction to Geospatial Technologies a lab course.
- The department should consider establishing an advisory board.

Conclusion

The program has an impressive array of accomplishments in developing partnerships in academic areas and community service as well as research. The dramatic growth in geospatial technology will only increase the opportunities. The curriculum is well thought out and covers as much of the technology as is possible for such as small program. The students are engaged and extremely happy with their choice of major. There are strong connections to other programs and opportunities exist to expand these in a number of areas.

The major concern is to recruit additional students to the program which will facilitate expansion. The key to this is marketing and outreach; highlight the opportunities in the program and get the information out to students in the region. Limitations are having a single faculty member responsible for teaching an array of geospatial courses, keeping up with changes in the technology, developing partnerships with other FS programs and continuing research and community service. A logical path to advance the program is for Academic Affairs to make a very modest investment in the form of a dedicated part time GIS lab tech. This would allow the program to develop a more expansive outreach effort working with local schools and youth groups as well as Community Colleges and would provide the ability to enhance the community service outreach. Since the University "summer" begins in late May this would be a perfect time to reach out to schools and conduct programs targeted on High School Juniors during the time period when the lab tech support for classes winds down. Additional marketing efforts to both internal and external students can be built upon the efforts already undertaken and by highlighting the impressive accomplishments and partnerships that have been developed.

In closing I would like to thank the department faculty, the library staff, the dean, provost and students for their hospitality and the informative discussions. It was an enjoyable experience and I hope to continue a relationship with the program.