CyberGIS in the Classroom: Reflections and Projections

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This position paper is a personal reflection based on my experiences teaching a course entitled ‘CyberGIS’ and my thoughts looking toward the future for cyberGIS curriculum development. These thoughts include personal biases with a tendency toward practical considerations for CyberGIS in the classroom rather than broader curriculum challenges. My experiences are drawn from teaching two CyberGIS courses, participating in the CyberGIS Fellows program, and leading the development of a new programming language for cyberGIS that was used in my CyberGIS course.

Perhaps surprisingly, I eliminated prerequisites from my CyberGIS course and instead relied on student discretion for enrollment, which was challenging and rewarding. Removing prerequisites encouraged non-Geography students to take the course and as a result 3 graduate students from Business enrolled with interests in supply chain management and business information systems. These students were especially interested in the social media analytics portion of my course. While these students had no GIS training, they appreciated the value of GIS and cyberGIS, had a strong grasp of statistics, and often brought a different perspective to the discussion. There is often a desire to create deep prerequisite pipelines so students enter our courses with expert-level skills and knowledge. However, these deep pipelines can be 'leaky' and we may lose great students, especially those outside of Geography. Flattening a cyberGIS curriculum provides multiple entry points for students interested in the various aspects of cyberGIS including GIS, parallel computing, data science, or its applications. By drawing students from business, forestry, planning, or computer science, a robust cyberGIS curriculum can create interdisciplinary classes providing not only an engaging learning environment, but also preparing students for a future where collaboration across fields or business units is commonplace.

The course was redesigned after the first offering. In the first iteration the course was divided into four sections: Introduction to CyberGIS (3 weeks), Services and Databases (5 weeks), Cyberinfrastructure and Web-enabled Technologies (4 weeks), and Group Research Project (4 weeks). The course looked broadly at the use, design, and development of cyberGIS and related technologies including geo-enabled social media, spatial databases, and spatial data infrastructures. The CyberGIS Fellows program enabled me to redesign the course to include parallel and high-performance computing (HPC). The Parallel Cartographic Modeling Language (PCML) is an open source programming language that is designed to be easy to use and automatically parallelize spatial data processing (https://github.com/hpcgislab/pcml). The course was divided into three sections in the second iteration: Introduction to CyberGIS (6 weeks), Spatial Data Processing and Services (6 weeks), and Web Portals (4 weeks). The second iteration de-emphasized spatial databases, emphasized programming fundamentals, and introduced HPC concepts such as speedup and Amdahl’s Law. Both iterations culminated in a final project in which students designed and developed a component of cyberGIS. The challenge of designing a CyberGIS course, like many GIS courses, is selecting from the countless concepts and technologies to cover. An equally valuable course would be one that looked outward toward the various applications of cyberGIS rather than inward at the 'guts' of cyberGIS. Naturally this would be a very different course and likely would attract a different student population that would nevertheless be engaging to all. I thoroughly enjoyed teaching both courses and student feedback was very positive.
I experienced several practical challenges that are worth noting. Eliminating prerequisites to encourage an interdisciplinary class required a clear description regarding expectations and quick ramp-up period in the beginning of each course to get all students up to speed (i.e., expectations for students were high). The order of topics was important due to varying skills and abilities, and both courses benefited by being adapted slightly to the students that enrolled. Interestingly, I found some students who may have benefited from the course were intimidated and opted not to enroll (based on personal conversations) while other students were drawn because they recognized the changing landscape of GIS and wanted to learn more about 'cyber' and 'big data.' In-class exercises and peer-based learning was vital to ensure each student had sufficient experience to excel in the class. These courses also require constant adaptation to keep pace with changes in technology (e.g., changes in APIs, web-technologies, packages and tools). They also demand a knowledgeable instructor and computational infrastructure for experimentation, which may be challenging for some institutions.

There are also opportunities for educators and students alike. CyberGIS as a system (Wang, et al. 2012) provides new tools to explore topics typically not covered in a traditional Geography/GIS curriculum such as geo-enabled social media data analytics (unstructured geospatial data), volunteered geographic information and crowd sourcing, and science gateways. CyberGIS as a science provides new avenues for Geography/GIS students to gain a deeper understanding of the concepts and theories, or explore the depths of spatial databases and computational methods. Perhaps more importantly it exposes these students to computational thinking. As a cyberGIS curriculum emerges I see tremendous promise in merging computational and spatial thinking. There is an untapped synergy between these two ways of thinking that once unleashed could lead to transformative learning and research opportunities.

Drawing on my experiences and looking toward the future, I think it is vital to reduce barriers for teaching and learning cyberGIS. Not all learners will be expert programmers with a combined interest in GIS and HPC and have a natural aptitude for database design. Similarly not all instructors will be knowledgeable in all areas of cyberGIS. There is an opportunity for making cyberGIS approachable in a well-structured curriculum. For example, I refined my materials to introduce cyberGIS to non-technical audiences. I find these materials help ease the intimidation and makes an often formidable looking "cyberGIS” more approachable. I also began experimenting with interactive online tools and multimedia for cyberGIS. I piloted several interactive mini-modules in my cyberGIS course in which students were shown simple non-technical stories that illustrated a key concept such as parallel computing. In this way, students explore and experiment with straightforward examples to gain conceptual understanding before getting bogged down in technical details. These online and digital platforms are also promising avenues for broadening outreach to more types of learners including self-learners, GIS practitioners, or learners at institutions that do not offer cyberGIS courses. Creating an effective online curriculum opens the educational door for these learners thus broadening the impact of cyberGIS.

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References: