Core Tenets for Success: Teaching with GIS

This document is intended to be used as a guideline for educators and others conducting professional development events involving Geographic Information Systems (GIS) and related technologies (GPS, Remote Sensing, web-mapping). These professional development events include hands-on workshops and institutes in face-to-face mode and via online courses, for educators at all levels of education, both formal and informal, worldwide. It may also be useful in teaching with GIS where students range in age from youth to adult. This document does not pretend to give every bit of advice on conducting GIS classes and training events, but it is hoped that these selected elements are helpful. For skimming the most salient points, read the words *in italics* after each bullet point. For more guidance on teaching with GIS, network with the GIS education community via http://edcommunity.esri.com, the Ed-GIS listserv (https://list.terc.edu/mailman/listinfo/edgis), with mentors via http://www.geomentor.org, with local and regional educators, and via other means.

What does GIS professional development for educators look like? How can it be successfully conducted? This document offers concrete suggestions.

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A. Strategies for Conducting a Successful GIS Training Event

[A1.] *Most Pressing Needs.* One strategy to help attendees realize the importance of using geotechnologies in education is to ask attendees to identify what they consider to be the most pressing problems in their community, region, country, and world. These could include employment, crime,

climate change, biodiversity loss, urban sprawl, water availability and quality, human health, energy, transportation, or other issues. Refrain from **giving** the list, but rather, encourage the attendees to think about the issues and have **them** provide the list. After the discussion has gone on for awhile, you, as the trainer, then should focus on the thread that ties them all together—geography and location. Then discuss that GIS is a tool created to help people solve and grapple with these problems from local to global, on a daily basis.

[A2.] *A Day In the Life.* Discuss a typical day in your life, and then ask about the daily life of one or more of the attendees to get them involved in the discussion. Then discuss how GIS works behind the scenes at each part of your day--to power the electricity that rang your alarm, to help the orange growers to grow the crops from which your juice came, to efficiently routing the bus that you are on, and so on. Use the "GIS Touches Our Everyday Lives" animation (http://www.josephkerski.com/data/gis_touches_our_everyday_lives.swf) and related article (http://rohitgarg.wordpress.com/2009/07/09/gis-touches-all-our-lives-everyday/) if you need additional links to how GIS impacts us all. Discuss how GIS may be like an elevator—not usually calling attention to itself, and operating behind the scenes, but essential to efficient operations. And just as the development of the elevator made skyscrapers possible, GIS makes solutions possible and "big dreams" a reality.

[A3.] *You are Learning Too.* Adopt the attitude that you are learning alongside the students (even if the students are your teacher peers). If, or more likely, **when** you don't know the answer to a question, you adopt the "I don't know…let's do some investigating together and find out" philosophy. This will send a powerful modeling message. Stress that one of the benefits of training is to learn together, and one of the key components of GIS is people—building a network of people is critical to success in GIS.

[A4.] *One vs. Two Groups.* If you have participants who might logically be divided into experienced and novice with GIS and/or with computers, and you have more than one instructor, consider dividing the participants into a "thorough investigation" and a "special topics" group. These names are not set in stone, but choose names other than "beginning" and "advanced" so as not to cause wistful feelings or to pigeonhole people. This allows the former group to start with ready-to-go lessons (such as in *Mapping Our World* or others on ArcLessons, while allowing the latter group to concentrate on specific skills, such as using spatial statistics or picture markers. If you do this, provide ample opportunities for the entire group to interact and have discussion, and also allow participants to flow back and forth between the groups as need be. In other words, minimize the "division" between the groups; make it a fuzzy boundary, not a wall.

[A5.] *Include Students.* Consider including some students in your hands-on teacher trainings. Teachers will then see how rapidly students can handle the technology; i.e. they may more quickly grasp *how* to perform a technical task, but they will also see that students don't always understand *why* to do something. Having students there will speak volumes more than merely having you **say** "students can do this easily," because the teachers there will see right in front of them, students tackling problems with GIS. True, it does complicate things logistically to get students to attend your institutes, but in my experience, it has been well worth the effort. Keep it manageable, though, with your main focus on the educators if you are indeed conducting an "educator" event.

[A6.] *Use Students As Mentors.* In your trainings, encourage those who will be teaching with GIS to be observant to identify those students who can become classroom experts for taking on additional projects or preparing data sets, and who can be effective peer mentors for their classmates.

[A7.] *Make It Interdisciplinary.* Consider requiring or encouraging a variety of educators involved from different grade levels (in primary and secondary), different departments (at a university), and different subjects taught. In this way, your discussions will be enriched, and geospatial technology will be recognized as something that is appropriate for all, not locked within the control of one discipline.

[A8.] *Pair Educators, Administrators, and IT Support Staff.* Consider requiring or at least encouraging teachers/professors from the same educational institution to attend with 1 of their IT support staff and an administrator. This team approach has been shown to greatly increase the adoption rate of geospatial technologies at an institution because the support staff and administration is on board from the start.

[A9.] *Set the Tone.* Set the tone the first day for your workshop: Encouraging questions and discussions, starting and ending on time, being open to change, working hard and expecting the participants to do the same, and so on. Reward those who are on time by starting on time and even by giving them a prize. Consider giving prizes for those who were the first to register for the event, or the first to sign up for the Google Group or a social media group that you have set up for the event.

[A10.] *Include Informal Educators.* Consider including informal instructors – museum professionals, after school programs, 4-H, Boys Clubs, Girl Scouts, YWCA, and so on. GIS will be seen as not just for school/campus, but rather, as something that encourages service learning, community based, life skills. Encourage attendees in your workshops to get involved in their communities.

[A11.] *Start Small.* Show success stories in the *Esri News for Education* (http://www.esri.com/industries/education/community/ed-newsletter) magazine, *ArcNews,* and elsewhere, but start small, focusing on activities where participants can see and *do* something effective in 1 minute, 5 minutes, then 30 minutes. People right away want to do community-based or projects that can take months, and get frustrated if they can't complete these. Use your own lessons or from others, and those in packages such as *Our World* or *The GIS Guide to Public Domain Data* or *Spatial Mathematics* for these activities.

[A12.] *Customize.* Customize each institute to the audience. Be sure to vary your activities in each institute, even if you are training the same type of audience, to keep your own skills moving forward and your enthusiasm fresh. If you are teaching multiple institutes, do at least one new activity in each, again, to keep you enthused and moving forward. This requires a great deal more preparation than a blanket template for each institute, but is worth the time investment.

[A13.] *Focus on Employment Pathways.* Give some attention in each professional development event about the innumerable ways in which GIS is used, so attendees will recognize that it offers pathways to employment as well as the capability to be used in a way that could directly benefit people, the

community, and the planet. Include that GIS is a green technology. The Map Museum site (from the annual map books)(http://www.esri.com/mapmuseum) is an excellent tool to use in this way.

[A14.] *Use Outside Speakers With Care.* Consider tapping into the local GIS community for speakers at your events. Use this with caution, though, keeping outside presentations short and focused. Many are enthusiastic but some are not necessarily good teachers. Seek those who are not just good technically, but are effective speakers.

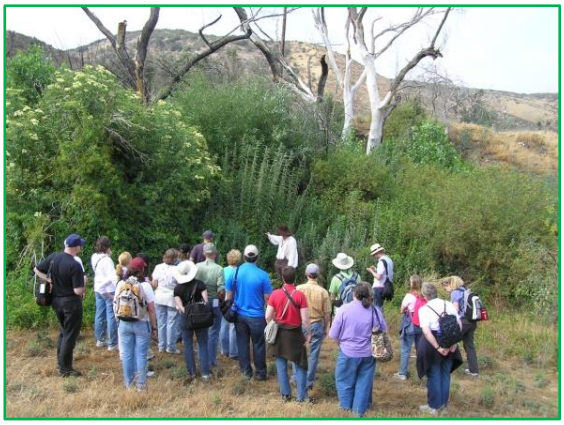
[A15.] *Face To Face Opportunities For Online Learners.* If you are strictly conducting online workshops, webinars, and courses, consider an opportunity to gather even a part of your community for a face-to-face workshop, or meeting at a conference, to build community.

[A16.] *Build Community.* Avoid "one-shot" institutes! Build online networking opportunities before, during, and after your face-to-face institute. There is no shortage of tools nowadays to do this—Google Groups, Wiggio, Facebook, Moodle, webinar tools (GoToWebinar, WebEx, Adobe Connect, etc.), listservs, and more. This provides the critical difference between holding a one-time GIS training versus establishing a GIS community. The implementation rate of GIS in the classroom will be much higher when you establish the community support. Make sure that **you** are participating often in the online community so that they are also connecting with you as the institute instructor before the institute even begins, but make sure you are not **the** focal point. The focal point is actually the community—you don't want them to depend too much on you.

[A17.] *Learn and Grapple With Local Issues.* Take the time to learn about the issues of concern, the geography, and the history of the place where you are conducting a GIS institute before the institute begins. Your institute will be enhanced because what you are modeling is community connection, not a "cookie cutter" approach to GIS training.

[A18.] *Share Lessons.* Encourage the educators to share the lessons that they develop with the worldwide community via ArcLessons (http://edcommunity.esri.com/arclessons) and in other ways. Consider this as a requirement to their successful completion of your institute. Consider building time in your institute for participants to begin work on creating their own lesson.

[A19.] *Include A Field Segment.* Make time whenever possible for a field segment; even if it is short. A good rule of thumb is to spend at least 20% of your institute time in the field. For a 5 day institute, therefore, one day would be in the field (including the GIS-to-GPS component in the lab). For a 1 day institute, this could be an hour or two. Valid short activities include "Measuring the circumference of the Earth," setting up a short geocaching or Earthcaching course, and drawing shapes and names with GPS tracks. In this way, you are combating any notion that GIS educators want kids to sit in computer labs all day. You are



linking GIS with field experiences, *No Child Left Inside* (AGI's Earth Science Week), *Last Child in the Woods* (book by Richard Louv), National Get Outdoors Day, National Lab Day, Earth Day, and other environmental and outside education efforts. It is also imperative to include smartphones in your field component—not just GPS receivers.

[A20.] *Break Up Lab Work with Field Activity.* For a multi-day institute, consider using the middle day for a field activity. For example, in a Monday through Friday institute, Wednesday should be your field day. For a 1 day institute, make the field work right after lunch, partly to avoid post-luncheon fatigue. After collecting data locally, spend the afternoon of the field day uploading coordinates and data into ArcGIS and ArcGIS Online, and hyperlinking media (video, text, photographs, sketches) to the field-collected data sites.

[A21.] *Include Team Building Activities.* For a multi-day institute, include a team-building activity during the first evening, such as a picnic and a geocaching event. The relationships built surrounding GIS are critical to its successful implementation.

[A22.] *Include Lightning Talks.* Typically, there is not enough time during an institute for participants to share what they are doing with the entire group (or more than just a few people in conversation). For a multi-day institute, therefore, include a "lightning talk" session, where participants can share the projects they are immersed in. Make this short; no more than 5 minutes for each participant, and cap the total time for this activity. For those who are not able to sign up and participate, encourage them to share with the group in an online forum.

[A23.] *Collect Participant Data for Research Studies.* In **every** institute, collect data about the participants, daily pre- and post-tests and/or surveys, and longitudinal studies, if possible. Even if you do not use the data right away, the field of GIS education is in continual need of data collected to contribute to the research. Become at least a bit familiar with body of GIS education research and realize that there is much to be done. You can help fill the gap!

[A24.] *Encourage Multiple Educators from Each School.* Encourage teams to participate in your workshop from each school (or if on a university campus, each department). The implementation rate of GIS will be higher if educators have even one other teammate with whom to share ideas, data, resources, lessons, and so on.

[A25.] *Connect to the Worldwide Community.* The educators in your workshops may feel connected to their fellow workshop participants, but make sure that the educators in your workshop realize that there **is** a worldwide GIS education community as well. Connect those educators to the greater community by providing them the pathways to organizations, conferences, blogs, listservs, other training events, books, key leaders in the field, e-magazines and printed journals, and research.

[A26.] *Include a Final Presentation.* At the conclusion of a training event or a series of training events with the same audience, consider including a competition or project presentation, and announce the time allotted for the presentation, conference style. The final project does not have to be GIS-centric, but GIS and spatial analysis should be an identifiable element. If time does not permit this, have each

person share with the group how they will implement what they have learned in the future. It lends a note of accountability and may be the bit of encouragement they need to truly implement GIS in their educational practice. Keep this short and focused.

[A27.] *Show Videos.* Take advantage of the myriad of GIS-related videos that are appearing weekly on the Internet in your instruction. Today's students are completely video-wired and will pay attention. Include a reflection time to discuss the video afterward. Or consider using the videos as the first thing that the participants see after a break to get them focused.

[A28.] *Consider Short, Repeated Exposures.* Consider short, repeated exposures: Hold after-school sessions for faculty in one school every 2nd and 4th Wednesdays of the month for 90 minutes each, for example. Use online methods as well for these exposures.

[A29.] *Consider Scaffolded Exposures.* Consider "scaffolded" exposures – an hour of demo, followed two+ weeks later by an afternoon of light hands-on, followed two+ weeks later by a day of hands-on including intro to GPS, followed two+ weeks later by a multi-day instruction event looking as much at how to implement within a curriculum.

[A30.] *Increasingly include Web-GIS.* If you have time for a 1-hour or a 1 day institute, consider making it entirely focused on web-based GIS. Use web GIS as your introductory piece in a multi-day institute and as an increasingly larger component in all institutes. There is still a place for Desktop ArcGIS but focus the bulk of your efforts on web based GIS. It is the way forward and needs to be embraced.

[A31.] *Include Natural Hazards or Current Events for Short Sessions.* If you have time for a short hands-on session, consider examining earthquakes around the world. This will incorporate a relevant, interesting phenomenon, human-environment interaction, and real-time data (download the last 7 days' earthquakes from the USGS earthquake center),

[A32.] *Make It Hands-On.* Hands-on is always better than a presentation, if you can garner a computer lab or use the bring-your-own-device model. Letting the participants do hands-on work is more effective than the words you could ever say. **Don't just show slides**!

[A33.] *Second Best: Do a Live Demo Over Slides.* If you cannot facilitate a hands-on workshop, giving a live GIS demonstration is more effective than a slide presentation. If you cannot do hands-on, then demonstrate the capabilities, ask questions, and teach with GIS; in other words, make it interactive.

[A34.] *Combine Demo with Slides.* If you truly **have** to show some slides, and sometimes, it is appropriate, show some of them, and then cut to a GIS demonstration. Consider interspersing your demo with your slides, using the demo to make your points.

[A35.] *Show Web-GIS in Your Presentation.* If you only have a 30-minute presentation, consider 10 minutes of slides and 20 minutes of demonstration. If you have access to the Internet and the presentation is too brief to do a desktop demo, show some web-based GIS sites that illustrate a variety of GIS applications in education.

[A36.] *Know Your Audience.* Find out the background and needs of your audience and then carefully meet the needs of your audience. GIS is diverse and so are the people drawn to GIS. Vary the applications, scales, themes, and issues discussed in your presentation. Don't just show parcels or sewer lines! Touch on administrative, research, and instructional components of GIS in education.

[A37.] *Use Short, Doable Lessons.* Other short, doable, interesting lessons that attendees can have success with for a short hands-on session include the analysis of hurricanes using National Atlas and desktop GIS, analyzing neighborhood demographics in the community you are teaching in, Water World from *Our World* (climate change), and analyzing the 10 largest cities in the world for the past 2000 years (*Our World).*

[A38.] *Evaluate Daily.* Use a 1 page daily evaluation (such as the Critical Incident Questionnaire, adapted from *Becoming a Critically Reflective Teacher)* at the end of each day's session, read these and make adjustments for the next day, and—most importantly—discuss the changes that you are making during the next morning's opening moments with your participants. It is critically important for the participants to know that you are paying attention to their evaluations and their needs.

[A39.] *Break Up Each Day Into Definite Activity Blocks.* Break up each day's instruction into blocks of 1.5 hours each. Toward the end of the week (if you have a week-long institute), include more independent practice time.

[A40.] *Break Up Each Day with Different Instructional Styles.* Vary he instructional style between group activities, instructor-led activities, and individual work and activities, parking lot activities, discussion, gallery walks (where 1 section of your attendees demo their project at their workstation and the rest of the attendees walk to these workstations and ask questions for those who are presenting their projects, then switch groups).

[A41.] *Team Teach.* It is helpful to have a partner when you teach a GIS workshop, for the variety of instructional styles for the attendees, and to have at least 1 instructor serve as a technical "floater" throughout the classroom. It is more difficult to be the solo instructor when the technical questions arise, because you must debate whether to stop the whole class and address the concern, or address it during a break.

[A42.] *Consider the Demographics.* Consider your audience. If a goal, for example, is to model career pathways for a minorities-or-females in technology group, make sure that your instructional team reflects that demographic, if at all possible.

[A43.] *End With Success.* End with a short, easier activity that makes the attendees realize how far they have progressed in a short period of time through your training event.

[A44.] *Include non-GIS spatial activities.* Include tactile spatial but non-GIS activities to keep the attention focused on spatial learning using other tools. These could include work with topographic

maps (such as the Topo Match and Topo Bingo activities), acetate overlay activities (what is the missing theme?), geocaching on a short course that you set up ahead of time, creating 3-D models, and so on.

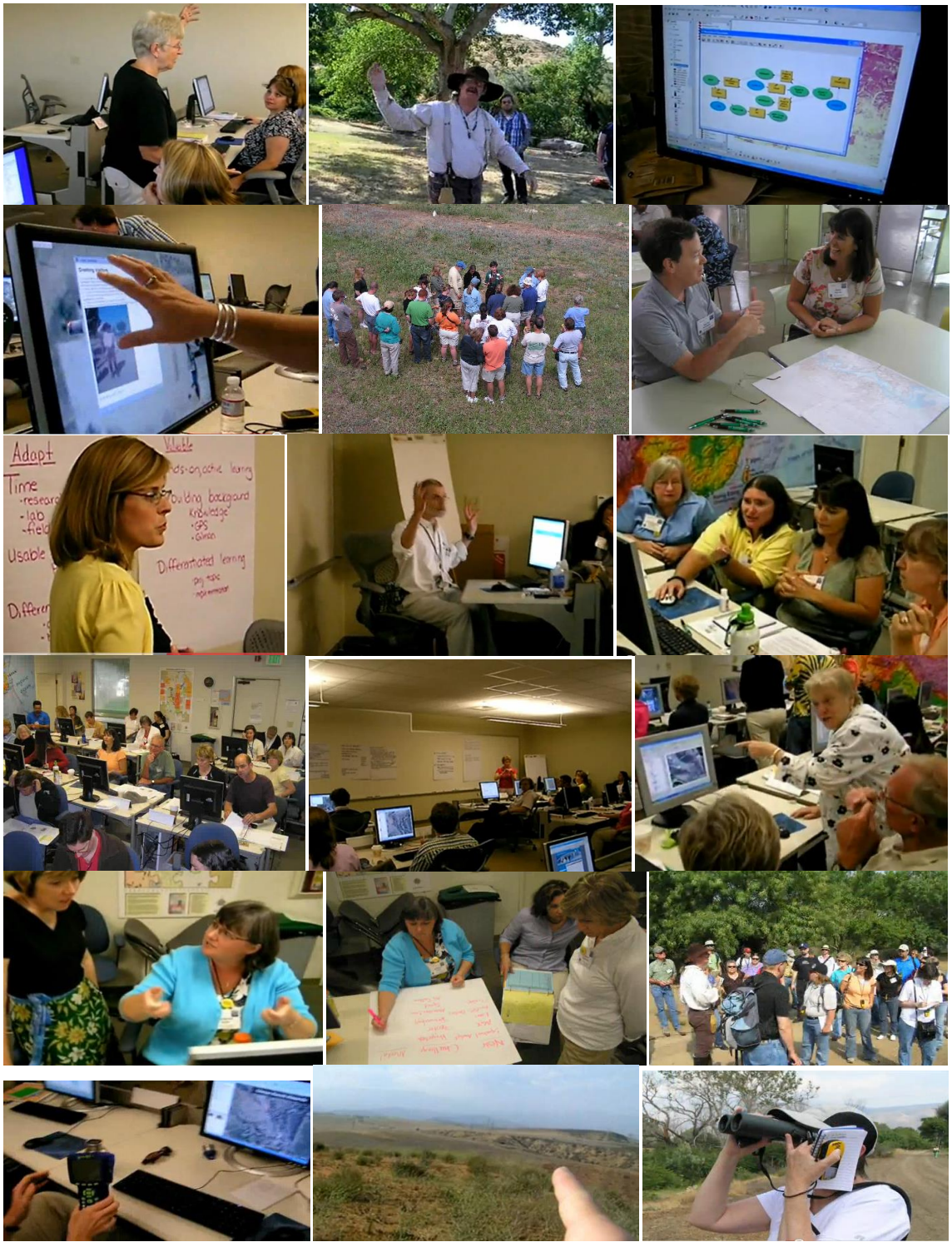
[A45.] *Keep to the Schedule.* While you don't need to be overly regimented, keep to the time schedules—lunch, return to dorm or hotel, lesson end time, and so on. Model punctuality and reward those who are there on time by beginning and ending on time. Attendees will get the message and (most) will follow your lead.

[A46.] *Consider Pre-Workshop Requirements or Preparation.* You cannot force attendees to do anything before your workshop begins. However, you can strongly encourage them to work through a small number of activities and readings. This builds community and enables you to move beyond the basics on the first day. Consider a small number of short readings or activities to get them started. Make sure they understand how to use or at least be familiar with some of the tools that you will use in the workshop. One of my mentors on this was Dr Ken Foote in his Virtual Geography Department workshop during the 1990s, where he put together short readings (in those days, in a physical notebook that he shipped to each attendee!) for the attendees. Since we had all read the same readings beforehand, we all had the same core background knowledge, which helped the whole institute become a success.

[A47.] *Have Fun!* Studies show that more content and skills are retained when attendees are enjoying themselves. Make your institutes interesting and fun. Look at interesting issues, topics, and current events. Anchor each to spatial thinking and geotechnologies.

[A48.] *What do you want your event to look like/feel like?* See the images below and this video: http://www.youtube.com/geographyuberalles#p/search/3/axyCR7vgUBg

What do you want YOUR institute to look like? Note the variety of settings, pedagogical techniques, action throughout, enthusiasm, peer mentoring, and projects in the institutes (examples from T3G) below.



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B. GIS Training Core Messages

[B1.] *Be The Teacher, Not the Software Guru.* Teachers need to think about what they are or must be skilled in – generalizing processes and asking thought-provoking questions instead of knowing software minutiae. This is particularly the case nowadays with nearly-continuous (or at least quarterly) updates to online software tools. Focus on the fact that this is **good** news for teachers, because it frees teachers up to do what they love to do the best—frame the inquiry-based questions. This is critically needed because the students may not be skilled in framing these questions nor with how to grapple with them without assistance.

[B2.] *Benefits of GIS in Education*

- *Value:* GIS in education adds value to education.
- *Benefit:* GIS in education benefits students, educators, society, and the planet.
- *Connection:* Emphasize the connections that using GIS has to 21st Century skills, to employment opportunities, to problem-based learning, and to educational content standards.
- *Partnerships:* Effective GIS in education occurs through active collaboration among students, faculty, community leaders, GIS practitioners, professional societies, educational institutions, and others.

[B3.] *Respect Attendees.* Respect attendees time during the workshop and the constraints and challenges that educators are under in their everyday work, and plan GIS activities accordingly. This includes reasonable expectations on what they will have time to do before the institute begins and after the institute ends, which is typically very little, given their other teaching responsibilities.

[B4.] *Illustrate the Many GIS Education Pathways.* Make it clear that there are many pathways to the use of GIS in education, and many valid models. Feature a wide variety of best practices. There is no "one size fits all." That can be freeing but also challenging to you as the instructor.

[B5.] *GIS Provides Holistic Learning.* Focus on the fact that GIS is a holistic computer learning tool, taking advantage of a myriad of skills, such as data management, downloading and using information from the Internet, critical thinking about data sources and quality, project management, and so on. In short, its use covers a multitude of functions, many of which are considered core computer competencies.

[B6.] *Bring Pedagogical Discussions to the Fore.* Each workshop should feature discussion about implementation of GIS in education, not just what buttons to press. The pedagogical discussions should be at least 1/3 of the total time in the workshop.

[B7.] *Model Spatial Thinking.* Each lesson and workshop should include just as much reflection and discussion about the types of spatial patterns visible or not visible, spatial relationships, trends, and the "whys of where" as questions that require a button/menu/tool to be accessed. In so doing, you are modeling good teaching practice and encouraging the development of spatial thinking. GIS (and geography) is as much or more about the "way of seeing the world" as it is about a body of content.

[B8.] *Teachers are Gatekeepers.* Take proper care and feeding of the educators in your workshops. In K-12 education, teachers are the gatekeepers. They can prevent almost anything from coming in if they don't want it in, and will bring something in despite hurdles if they really want it. They are vastly more important for effective implementation of GIS or any other innovation than anything else.

[B9.] *Make Friends with the IT Staff.* Information Technology (IT) staffs are other gatekeepers of sorts, wielding much power depending on the institution. Build good relationships with the IT people where you are teaching the institute and invite them to join you for part of the institute. In so doing, you are modeling best practices for the participants, who you want to encourage to build excellent and long-term relationships with their own IT staffs.

[B10.] *Include the Administrators.* Administrators are other gatekeepers, and encourage your participants to invite administrators to their GIS workshops. Once they are brought on board, if they become excited about what you are doing, they, like the IT staff, can be powerful advocates for computer equipment, software, staff support, time in the computer lab, and more.

C. Modeling Best Educational Practice

[C1.] *Empathize with the Educators.* Despite the ease of use of GIS compared to the days of command-line GIS software, don't sugar-coat GIS in education and pretend it is "easy." Empathize with the educators and salute them for their efforts. Using any inquiry-based methods and technology is more difficult than "memorize and regurgitate for the test." Remember that *"The best teaching methods are in fact the most difficult."—Piaget.* Recognize that educators in some ways have it more difficult than the industry or government GIS user, who only has to apply GIS to his or her own job. Not only do teachers have to learn how to run the software, but they have to learn how to teach with it. In addition, they have to grapple with a whole host of issues that do not even enter into industry or government, such as restricted access to a computer lab, blocked Internet sites, not being allowed to load one's own software or to download data, and so on.

[C2.] *Acknowledge Training Diversity.* Training needs to be tailored to the audience, GIS experience level, and the age/grade level of students taught. It should also be made clear that there are many valid types of GIS training for any given audience. In other words, a workshop from Trainer A for a group of high school technology teachers does not need to look exactly the same as that conducted by Trainer B. The diversity of geographic areas, local needs, state standards, national societal and educational climate, personality mix, skill level of the participants, workshop setting, and styles of the trainers mean that the trainings will also vary. Nevertheless, "best practices" do exist that can serve all GIS in education trainers.

[C3.] *Meet Your Audience's Needs.* Make the point that depending on the audience and the course, GIS instruction may focus on different points, or the same point in different ways. For example, when teaching a foundational course in GIScience, you might spend several days or even weeks on metadata, teaching students how to create it, catalog it, and use it. If you are teaching how to teach with GIS, you might give the students an undocumented data set. When they discover that they need to, say, symbolize the data based on an unknown attribute, or project the data, but lack information about the

data, then introduce the concept of metadata. Then have them work with a documented data set. The emphasis and the time spent on the topic are different depending on the audience.

[C4.] *Vary your pedagogical method.* Include at least one group activity, at least one activity where you are leading the class using a projector, and at least one activity where the participants are moving through a series of questions that you have given them, and one activity where they are working on a variety of projects on their own. Include a gallery walk where one group of participants gets up and visits another group who stay at their computers and show off what they have been working on. You are modeling the wide range of instructional methods that your participants could use in their own classrooms and showing the versatility of teaching with GIS.

[C5.] *GIS is Not Hard: **Thinking** Is Hard.* Keep returning to the message: GIS is not hard: Thinking is hard. Analyzing spatial patterns and helping students to verbalize and understand in a spatial thinking context—that is hard. But it is essential.

[C6.] *Post the What-If Questions.* Pose your own "what if" questions (what if we changed the scale, the location of the analysis, the buffer width, considered an additional variable, etc.) and encourage the participants to come up with their own "what if" questions. This takes advantage of one of the chief utilities of using GIS—to follow through on such questions, which few other tools in the classroom allow you to do. Most other software used in the classroom is "closed system", whereas GIS is an open system.

[C7.] Vary the instructional style. Include: modeling, guided practice, demo, do-it-yourself, reflection, questioning, gallery walks, one on one, slideshows, peer mentoring, reverse engineering, transferring ideas, gallery walk, think-pair-share, choropleth "what is the map theme" map quizzes, satellite image map quizzes (name the country, name the process, name the scale) post large post-it notes from groups, index-cards-ranking, throwing around a ball-and-catching it-then-sharing an idea.

D. Career Connections

[D1.] *Show Real Job Ads.* Show real job ads from geosearch.com, gisjobs.com, urisa.org, scgis.org, asprs.org, from local newspapers, and from other sources. Seeing the salaries and the duties is worth more than general statements that there are "lots of GIS jobs out there." Make sure some of these job ads are "cool", varied, and interesting!

[D2.] *Jobs that are not "GIS Jobs" but Jobs that Use GIS.* Emphasize that while there are "GIS jobs" but much more numerous are "jobs that use GIS". These jobs have a myriad of other titles, which may or may not even be related to geography or geospatial. They could be marketer, buyer, lawyer, planner, biologist, demographer, and thousands of others.

[D3.] *Don't Neglect the Non-GIS Skills.* Focus on the non-GIS skills that each job requires—speaking, writing, proposals, management, etc—and then encourage the participants to encourage their students to make sure they take such courses as mathematics, business, English Language Arts, and others so that they will be well-rounded enough to apply for these jobs in the future.

[D4.] *Discuss GIS Role In Employment.* Educators need to see that GIS will play a huge role in employment for **all** of their students (the digital natives) to a degree far exceeding what the role it has had for adults, and that the employment in geospatial fields goes far beyond geography. Indeed, one might argue that the business, health, planning, and other fields using GIS have far outpaced geography and natural resources applications.

[D5.] *Keep Critical Thinking Skills at the Forefront.* Educators need to hear business people saying "We need workers who can think critically, find information and make decisions, cope with changing conditions, integrate information, collaborate, communicate, and learn, learn, learn." In other words, what we hear is that "Test scores are fine, but we want evidence of deep and critical thought, and workers who know how to read, write, communicate, and collaborate."

E. GIS Technology Messages

[E1.] *Explain GIS vs. Other Geotechnologies.* Explain how GIS, GIScience, RS, GPS, web mapping, and Virtual Globes interact and fit together in the geotechnologies.

[E2.] *Esri Software Terms.* Since many of the Esri terms sound similar, you should have a clear understanding of the differences between ArcGIS Online map viewer, ArcGIS Explorer Online, ArcGIS Explorer Desktop, and ArcGIS desktop. Philosophy: Use the most appropriate tool for the job. Desktop is not "better" than Online, many tools need to be used from time to time for effective teaching and learning.

[E3.] *Online Tools Require Less Step-by-Step.* Be firm in your statements that online tools don't need a manual—they are more intuitive, and they change rapidly. Manuals become quickly outdated. Lessons don't need to be necessarily written-out-and-formalized to take advantage of these tools. They can be used quickly and easily to teach concepts in many disciplines.

[E4.] *Explain GIS vs. Virtual Globes.* With the advent of virtual globe software, there are many questions about the differences between GIS and virtual globes such as Google Earth, ArcGIS Explorer, and NASA World Wind. Emphasize the difference between visualization and analysis, and illustrate how GIS was created to help the user analyze information to solve problems and grapple with issues.

[E5.] *Model Experimentation with the Software.* Point out the ease of the tool wizard and other interface enhancements that have occurred inside GIS software over the years. Point out that there is nothing wrong with experimenting with the tools or the variables placed in those wizards; just make sure you have backed up your data sets!

[E6.] *No Buttonology.* Teaching with GIS is not just about running the software ("buttonology"), and any training that looks only at buttonology will not only be limited in effectiveness to only teaching the software, teaching software skills out of context is in itself rather ineffective. GIS software changes, and therefore it is more important to understand what overlay *is*, for example, rather than how to access the overlay function.

[E7.] *Ask Questions and Examine Your Data Before and After Running Each Function.* Before each function that you run, ask the attendees to make a hypothesis on what the map will look like as a result. After running the function, ask if that is what was expected, and if not, why not, if so, why? Verify a sample of your results (such as measuring the buffer distances in a few places). Then, even more importantly, discuss such issues as the spatial patterns that result or did not result, the difference that a data set generated at a different scale would have made, and so on. Also include frequent discussions about how this lesson could be used in the educators' own classroom, whether the participants would use it, whether they would modify it, and so on.

[E8.] *Job Shadowing and Connection to GIS Professionals.* An important part of each professional development opportunity is to connect the attendees with the greater GIS community--project people, users, managers, employers, organizations, conferences, and more. This can funnel into "job shadowing" opportunities or even internships. Consider connecting with URISA's GIS Corps.

F. Teaching with GIS and Teaching About GIS: Philosophies

[F1.] *You Don't Need To Be The Software Expert.* You don't need to be the "expert" in your trainings, and neither to your attendees when they in turn teach with and about GIS. Allow yourself, and them, to say, "I don't know—let's investigate that and find out together!" Similar to any computer application (DreamWeaver, Word, Excel, PhotoShop), you don't know every function and command in those programs. You learn those functions on a "need to know" basis, and so it is with GIS. Students will learn the functions much more quickly.

[F2.] *Repeat, Repeat.* Repetition is a key to success with GIS. If a function does not work, it is actually quite useful, because it forces you to try it again and cement it in your brain.

[F3.]. *Competition can also be useful*. In a workshop, use selected bits of competition. Attendees might be motivated: "I don't want to be the only one to show up with nothing done or no map created."

[F4.] *Show GIS in Action.* Educators need to see GIS, and hear about it from other educators multiple times.

[F5.] *Critical Thinking's Connection to Employment.* We need workers who are good critical thinkers, and GIS can turbocharge their immersion in critical thinking. It is important for the educator to bring up those moments. They can do this in questions such as "Where did this data come from, and how does it impact our analysis?" "How does the scale impact your analysis?"

[F6.] *Explore and Process.* Educators need opportunities to explore GIS and then to talk about and process the issues of content, data, technology, and especially pedagogy.

G. Materials and Hardware

[G1.] *Incorporate BYOD (Bring Your Own Device).* Computer labs are rapidly disappearing from educational institutions. It is increasingly common in educational practice for universities, schools, and after school program students to bring their own laptops, tablets, and other mobile devices and use them, and for administrators to support this model. As the instructor, you may wish to consider this. There are pros and cons. Some devices can be small and confining for some web GIS applications. With the plethora of virus protections, operating systems, service packs, patches, and so on, troubleshooting different computers can quickly overshadow your main instructional goal. While having a fleet of devices that you have control over and that you have prepared ahead of time may seem ideal, today's world of online GIS makes BYOD more and more viable as time goes on, and you will need to embrace this platform.

[G2.]. *Try the "Bring Your Own GPS and Smartphones" model.* The above discussion holds true as well for GPS receivers and smartphones. Again, for beginners, try to use a fleet of the same GPS model so that all the menus are the same. If some attendees are comfortable with their own receiver, they may use it, of course, but oftentimes they are not as familiar with all of its functions as they think they are, and so, use caution to avoid troubleshooting each individual's GPS unit. With smartphones, strongly consider requiring the attendees to download a few apps that you will be using in your institute *before* the institute begins. These apps include a GPS tracking device (MyTracks or Motion X GPS), the ArcGIS app, and any sensor apps for recording albedo, noise, or other types of data.

It is understandable for attendees to want to use their own laptops/tablets, GPS receivers, and smartphones, and advisable that they get comfortable using their OWN equipment. Therefore, accommodate as much as you can, but discuss challenges and the fine line you walk with this as an instructor.

[G3.] *Lab Configuration Considerations.* If you have a choice, configure the furniture and computer workspaces in pods, or along the walls, rather than traditional rows facing forward. The traditional setup discourages interaction between the attendees, and also inhibits your ability to help someone due to space constraints. For the bring-your-own-device (BYOD) model, make sure you have plenty of table space for your attendees to be comfortable working so they will be ready to learn.

[G4.] *Use Notebooks.* Paper notebooks are still valued even in the electronic age in some settings. Provide an empty binder and hand out materials as the institute progresses, rather than handing out an already-filled binder. In this way, participants will know how to use the binder and will more often use it, which is your goal! However, limit the printed material overall, as it tends to be used less and less with each passing year. Rather, keep the electronic version online up to date.

[G5.] *Facilities Management.* Build a good relationship with the lab or facility managers who work where you are teaching. Tell them how much you appreciate their support. Get into the lab or room(s) to set up a minimum of one day ahead of time. Ideally, you want adequate computers, network access,

technical support, lighting that can be adjusted, heating/cooling, good chairs, desk space, printers (color, ideally), a white board, snacks, and poster-sized post-it notes. Avoid the expense of buying bottled water but rather, perhaps provide a water bottle that attendees can fill during the week.

[G6.] *Finances.* Consider that if your institute is free, you will have more no-shows. Therefore, consider charging a small amount so attendees will value it more, and the fee also may allow you to provide snacks and beverages. If you are relying on teaching GIS institutes for income, then you have other considerations as well. Consider developing a wait-list that you can tap into if need be. Ideally, delegate the logistics and payment from the attendees to someone else so you can concentrate on building community, constructing curriculum, and planning a top-notch institute.

H. Lab Preparation

[H1.] *Room Configuration.* Will the set up meet your needs? Is there adequate space for you to reach all of the participants if they have questions? You might not be able to make large changes in the lab, but some small adjustments might make a big improvement in your course.

[H2.] *Arrive Early.* How early will the facility managers allow you to enter the lab? Will you have enough time to prepare? For a week-long workshop, try to be in the lab a full day before the training event begins to load software and data. Be firm with the lab managers: The more preparation time you have, the better the training will be. Then sing the praises of the lab managers for their support.

[H3.] *Discuss a Lab-Less Institution.* Schools and universities are increasingly doing away with their labs. Discuss the implications of this and how it may impact your training event. Will you have to rent your equipment? Will you ask attendees to BYOD (Bring Their Own Device)? Can and how can those devices connect to the local Internet?

[H4.] *23-Item Quick List of What to Check for in the teaching Lab.*

(1) Load and test software. Minimum needed:

{1} Web Browser – IE (not recommended), Safari, Firefox, Chrome.
{2} ArcGIS Explorer Desktop, Esri. Free download from: http://www.esri.com/arcgisexplorer
{3} ArcGIS Explorer Online – if you plan to use it for presentations, make sure MS Silverlight plug-in is installed.
{4} ArcGIS- latest version, Esri. In mid-2013, ArcGIS 10.2 was launched.
{5} Minnesota DNR GPS 6.0. Free download from: http://www.dnr.state.mn.us/mis/gis/DNRGPS/DNRGPS.html
{6} Notepad (best) or Wordpad.
{7} Optional: Geotagging photo software such as Microsoft Pro Photo tools.

(2) For ArcGIS, make sure you have the proper license codes.

(3) Load and test ArcGIS Explorer with some data from ArcGIS Online and your own data. Critical: Visit the locations that you are going to work with in ArcGIS Explorer before the class begins, so that those locations are in the computer's cache. Then, when the attendees work through your exercises in the class, the images are already stored in the computer's memory cache, rather than having to retrieve them from the Internet. This will make those lessons much more enjoyable and a better learning experience.

(4) Load and test other programs: DNR GPS, Excel, etc.

(5) Load data. Ideally, use Dropbox.com for course documents and data depository.

(6) Make sure that there is a writable folder for the participants.

(7) Make sure the computers have a program registered to read JPG, GIFs, and other images.

(8) Test the printer if you will be using one.

(9) Test Internet connection with web sites that you will visit: National Atlas, ArcGIS Online, gapminder, worldmapper.org, and others.

(10) Test Flash plug in on Web browser that you are using so that any Flash-based Web GIS maps work.

(11) Rights and passwords:
Password for accessing the computers.
Will it be an admin account or a student account?
Will attendees be able to download data or install programs on the computers?
Do you have admin rights or have access to someone who does?
Is the Internet filtered or blocked in any way?
Make sure the computers can at least write temporary files.
Passwords for wireless?

(12) Critical: If you are using cables to bring data from GPS receivers to desktop computers: Test GPS cables with computers and make sure that computers recognize the GPS device (especially if you are using GPS cables with USB connections). → Computer ports are notoriously buggy! Thus, if you can avoid this type of work, and transfer data via smartphones and the cloud, that would be ideal. It may still be a valuable experience but make sure it all works beforehand.

(13) Critical: Turn on GPS receivers in the area where you will be teaching and leave them on until they have found their location. This is important especially if the receivers have been moved hundreds of miles/km from the last place you were teaching, because it takes awhile for the

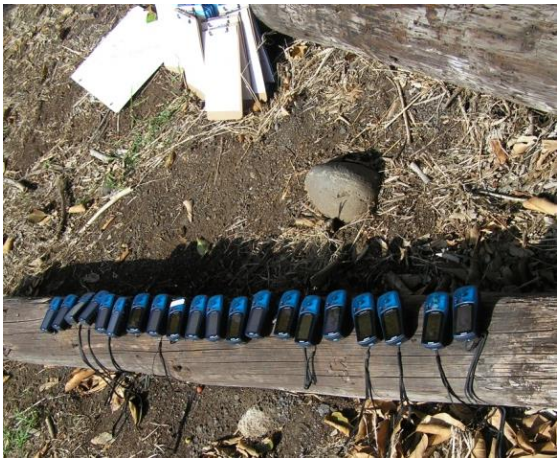
receivers to “find” their new location; sometimes 5 or 10 minutes or more. If you do this before the workshop begins, then your attendees won’t be “standing around” waiting for a location fix—they can go outside and start collecting data right away (in only a minute or two).

(14) Set out handout materials, name badges, and so on. Materials could include: The daily evaluation form, Explore Your World with a GIS poster, GIS Day poster, GIS In education articles, 60 day evaluation ArcGIS CDs, Esri Map Books, Esri Press catalog, issues of Esri GIS News for education, paper copies of GIS lessons. Make sure you have a table to do this; ideally, a group of tables. Again, limit your handouts and make sure all your key content is available online such as in Dropbox.com.

(15) Do you need external speakers for sound for the movies that you will show and multimedia you will hyperlink to?

(16) Equipment check-list:

- Printer,
- speakers,
- extension cord,
- computer projector,
- GPS cables,
- GPS receivers,
- batteries for GPS,
- camera,
- camera cable,
- Smartphones with GPS and GIS apps installed.



(17) Hyperlinking preparation. Take photographs and video at field site ahead of time, if possible, so that participants will have something to hyperlink to if they cannot upload their own photographs.

(18) Emergencies and Special Needs. Emergencies do happen and you need to be prepared for them.

- Is the lab accessible to those with disabilities?
- Is there a way for those in the lab to get in touch with the outside world and vice versa?
- Is there an emergency evacuation plan?
- Do you have a plan if someone has a medical emergency?
- Do you have a back-up instructional plan if the power goes out?

(19) Are you using your own computer or the lab computer for your teaching station? If you are using your own computer, do you have access to the Internet on it as a new node on the network?

(20) Do you have the contact information for the lab tech person?

(21) Will the participants have access to the software and the lab after training?

(22) Will the participants be allowed to use their own laptops?

(23) Does the lab have access to a shared drive (very useful before and during the class for sharing data and installing software without having to visit each computer individually).

I. 20 Considerations in Setting Up Your Own GIS Training Events

While not intended to be a comprehensive list, the following are considerations that you need to be thinking about when setting up your own GIS training events for educators:

(1) Lab and technology setup (see items in section H above).

(2) Number of participants in the workshop.

(3) Number of staffpersons/trainers in the workshop.

(4) Duration of workshop.

(5) Timing of each activity in the workshop.

(6) Content of each activity in the workshop.

(7) Annual timeline to plan for participants.

(8) Annual timeline to plan for staff.

(9) Instructional focus.

(10) Instructional modes.

(11) Application process and content. Will you include a GIS or technology project as part of the application process?

(12) Cost to applicants. If the workshop is funded by a grant, what will the grant pay for? If the workshop is completely free to the participants, plan for more "no shows."

(13) Logistics.

(14) Follow-up planned for participants.

(15) Expectations and requirements that instructors have for participants before, during, and after the workshop.

(16) Communication responsibilities for instructors and participants before, during, and after workshop.

(17) Evaluation methods and procedures.

(18) What fee will the instructors charge, if any?

(19) What kind of approvals are needed with the site's administrators (at a private company, school district, university, community college, museum, library, or other site)? When are those approvals needed?

(20) Should you overfill the workshop, expecting a few to cancel? Or should you have a "wait list" in some sort of priority order?

J. Top 20 GIS Technical Skills

Most top 20 lists are open to debate, and no top 10 GIS skills list fits the needs of every audience that you are training. However, these skills have been considered by many to be core to GIS education for over 20 years. They focus on what sets GIS apart from visualization: spatial analysis.

(1) Working with a multitude of devices in the BYOD model: smartphones, GPS receivers, probes, tablets, laptops, Mac/PC operating systems.

(2) Moving spatial data to and from the cloud to the desktop GIS environments and integrating the two, and knowing the advantages of the cloud and desktop environments.

(3) Understanding how to use data sources, data quality, and data formats. Knowing how to interpret metadata.

(4) Understanding how to **create** and host data. Knowing how to format and populate metadata.

(5) Knowing when and how to share data vs. keeping it private vs. keeping it in a closed group.

(6) Understanding the differences between public and organizational ArcGIS Online accounts, both from the data users' standpoint and from the instructional standpoint.

(7) Understanding the differences between types of data hosted in the ArcGIS Online environment: map notes, multimedia, zipped shapefiles, feature services, raster services, editable feature services, layer packages, map packages, and so on.

(8) Knowing how to collect data (tracks and waypoints) using a GPS receiver and with a cell phone, and knowing how to collect data with a smartphone using the ArcGIS app, including with editable feature services.

(9) Knowing how to map x y data with a variety of techniques and platforms, such as adding a simple CSV spreadsheet file with addresses or latitude-coordinate pairs. The data could be from a smartphone, GPS, or from online or hand-coded data sets such as the locations of water wells, wildfires, or tornadoes.

(10) Knowing how to manage a data collection assignment, including setting it up, conducting it, assessing it, and modeling good instructional practice.

(11) Knowing how to tell stories and communicate using a variety of GIS tools and presentation techniques, including ArcGIS Online presentations, multimedia, and bookmarks.

(12) Making and interpreting thematic maps: Changing variables and classification methods to create choropleth thematic maps. Why do the patterns exist?

(13) Selecting and querying data. Do this in both the raster (map calculator) and vector (select by attribute, select by location) worlds. Use the selection to do additional analysis or to clip (reduce) data to a smaller set. Use selection and querying in ArcGIS Online mode as well.

(14) Tabular and spatial joins. Use tabular joins to map data in external spreadsheets. Use spatial joins to create new data (such as the number of earthquakes in each country of the world).

(15) Defining, changing, and working with map projections. Essential to successful GIS use. Use it to see things in a new way; for example, the Pacific Ring of Fire.

(16) Overlay operations. Do this in both the raster world (map calculator) and the vector world (erase, union, clip, intersect, etc). Use them to solve a spatial problem.

(17) Creating summary tables, graphs, and layouts. Use good cartographic design principles in layouts. Includes the creation and use of multiple data frames.

(18) Georeferencing unregistered images. Use this for scanned or otherwise unregistered maps.

(19) Embedding maps in web pages, blogs, and in other online documents, viewable on multiple platforms.

(20) Understanding copyright, privacy, sharing, and other related issues surrounding data and publishing GIS based information.

K. Top 10 GIS Educational Objectives That Using GIS Can Foster

This list is wide open to debate, but those that recur in each workshop are the following:

(1) Inquiry.

(2) Critical Thinking.

(3) Problem-solving.

(4) Peer mentoring.

(5) Field work.

(6) Local to global connections.

(7) The technology doesn't have the answers—you do.

(8) Maps are imperfect, but useful.

(9) You have responsibilities as a community and global citizen.

(10) You can make a difference!

I wish to acknowledge that while this document reflects my personal philosophies regarding GIS in education, the voices of the many influential and innovative colleagues who have shaped my thinking over the years are reflected throughout. To them I give my heartfelt gratitude and admiration. –Joseph Kerski

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