

## TEACHING CARTOGRAPHY USING MAP CRITIQUE EXERCISES A PROPOSED MODEL FOR A GIS CARTOGRAPHY COURSE

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**Abstract:** Geographic Information Systems (GIS) has increased in popularity over the years. With this came the need for teaching GIS analysts how to create better maps, since the end product of any GIS analysis is inevitably a map. Thus GIS cartography courses started to show up as a basic component of the curricula especially in the GIS certification programs taught in colleges and universities. The objective of this paper is to propose a model for designing map critique exercises, the method of delivery, and evaluating students' performance and improvement as they proceed through the course. This method has proven to be very effective, and this paper proposes this method as a standard model for designing and teaching GIS cartography courses.

**Introduction:** Compared to traditional cartography, GIS cartography has a shorter history. Traditional cartographic design received an abundance of research over the years while research in GIS cartography is rather limited. In order to understand better the issue of what is needed for a GIS cartography course one has to understand what concepts of cartographic design a GIS analyst needs to know.

While traditional cartographers would favor to comprehensively teach GIS analysts all the detailed theory and concepts of cartography, however, from the practical point of view one would limit such concepts to only what is useful and practical. The reason for this is that the majority of these GIS analysts (based on the author's experience in teaching GIS at a GIS software company), are specialized in applied sciences, where their job duties in most cases might require them to create a fast map for decision makers to make use of. Some of these analysts have to respond even faster especially when dealing with emergency response conditions. ESRI's GIS software through its progress has resulted in introducing more tools for speeding up the mapping production time for such analysts. Coupled with this, ESRI offered training for such analysts to support them in obtaining the required skills to use such tools.

Examples of such milestones appear in the following list: (See also Map, Chart and Data Production Timeline - IMTA website <http://www.maptrade.org/industry>):

1. Introduced its first *rule-based* text placement concept at ARC/INFO version 6.0.1 in 1992.
2. Introduced the *Basic cartographic design principles* 90-minutes workshop for the first time in 1993 at ESRI's International Users Conference, and has been delivered annually by the author ever since.
3. Introduced its first *interactive* page layout concept at ArcView version 2.0 in 1995.

4. Introduced its first *legend editor* and *automated* text placement concept at ArcView version 3.0 in 1997.
5. Introduced its first standalone *rule-based* text placement software with the standalone Maplex software version 3.1.1 in 1997.
6. Introduced a full day *Introduction to Cartography using ARC/INFO and ArcView* seminar as a pre-conference activity of ESRI's International Users Conference in 1998 and delivered by the author. It was renamed *Introduction to GIS cartography* in 1999, *Creating beautiful maps with ArcMap* in 2003, and *Creating better maps* in 2004 till present.
7. Added the *map layout templates* concept in its ArcGIS version 8.0 - ArcMap map-centric application in 1999.
8. Delivered *The 15-Minute Map: Creating a Basic Map in ArcMap* live training seminar (ESRI, Inc., 2002 – Presenter: Makram Murad-al-shaikh; rerecorded in 2007 by Matt Baker).
9. Introduced its *symbol editor* at ArcGIS version 9.0 in 2004.
10. Introduced the *Maplex Extension* to ArcGIS version 9.0 as the *rule-based* text placement tool in 2004.
11. Introduced *cartographic geoprocessing tools* at ArcGIS version 9.1 in 2005 to help in producing GIS layers for cartographic purposes.
12. Introduced the *cartographic representation* concept at ArcGIS version 9.2 in 2006 whereby multiple cartographic representations can be created and stored *in the database* for *multi users* and for *symbol standardization* across the organization.
13. Introduced the *Map Critique Station* at the ESRI's International Users Conference in 2006, where users bring their maps for critique by ESRI's cartographers and other guest cartographers. Users are given suggestions what software tools to use to improve their maps. This has been an annual event managed by the author ever since.
14. Introduced the *ESRI Mapping Center* (<http://mappingcenter.esri.com>) in 2007. Its goal is to help GIS software users make great looking maps with GIS using the same cartographic concepts and techniques that professional cartographers use.
15. Delivered *The one-minute cartographer* workshop (Buckley and Frye, 2009).
16. Introduced the *Map Templates* concept in 2009. Delivered the *Getting started with Map Templates* live training seminar (ESRI, Inc., 2009 – Presenters: Mark Ho and Charlie Frye).

Map critiquing was introduced in several learning experiences when teaching traditional cartography courses, for example Macey et al, 1988 and others at later dates. However, they reference the teaching in extensive details of cartographic theory and its application with elaborate reading assignments of several textbooks. This type of a course model may be useful for students majoring in cartography or for those who might be pursuing graduate level studies, where extensive cartographic theory is of prime importance. However, GIS analysts might not need such elaborate courses.

Hence the objective of this paper is to come up with a simpler model for a GIS cartography course that can help GIS analysts create an effective and useful map.

**Methodology:** The proposed model for a GIS cartography course is based on the author's experience of teaching a GIS cartography course for GIS certification programs in five different Southern California colleges and universities for over thirteen years. These are: San Bernardino Valley College, California State University

– San Bernardino, University of California – Riverside, Riverside Community College, and Loma Linda University.

Because of the difference in design structure of these GIS certification programs, the GIS cartography course was taught with different credits, hours of student contact, and number of times of student contact. (Murad-al-shaikh, 2003). However, they all concentrated on alternate lectures and critique exercises.

The lectures part of the course included delivery of the concepts listed in Table 1, taught with more concentration on the applied and practical aspect of cartography, specifically for GIS analysts, than on theoretical cartography.

|  |
|--|
| Introducing GIS and modern cartography                       |
| Map data accuracy and scale issues                           |
| Cartographic design principles and the communication channel |
| Projections  |
| Symbology and color in cartography                           |
| Generalization   |
| Statistical mapping  |
| Name placement   |
| Map critique   |

Table 1. Typical contents of a GIS cartography course taught in colleges and universities in California, USA. (Murad-al-shaikh, 2003)

The course concentrates on the design of maps for ease of use and how to manipulate the graphic characteristics of the map to create visual levels and thus introducing an inherent pattern of reading: leading the map reader in what is most important first and what is lesser important next, and so on. These visual levels are created in compliance with the map objective, audience, and distance of viewing, certainly applying all the visualization techniques possible to accomplish this with the available GIS tools.

Beauty in the map is considered as a secondary objective for a GIS analyst's map and for the purpose of this kind of a course and audience, however it is nevertheless encouraged but certainly will not constitute a major influence when grading. If time allows, methods of enhancing the aesthetic aspects of the map is discussed and how to achieve this with the available software. Another reason for this is to be fair in grading map assignments for this course when some of the attendees might be more versed in graphic art design and software than the majority of the class. The course does have a pre-requisite: an introductory level course on how to use the ESRI's ArcGIS software.

Four maps are used throughout the course.

1. The first map is an already finished printed map which is selected by the instructor (students can have the choice to bring a map from their work places if they preferred). This is marked 1a and 1b in Figure 1 below. A description of how this map is used will follow below.
2. Two major maps are repeatedly used in this course. Students will visit these maps a couple of times as the course progresses:

- a. The first map is a choropleth map of sub-saharan African countries (marked as 2a and 2b in Figure 1 below). Although students at this phase of the course are not yet introduced to the concepts of a choropleth map, however, the objective at this phase is more focused on what map components are necessary to include in the map and what map components are not needed, as well as what to look for in title wording (in relationship to the map content and its objective), and for the units used in the legend. The objective is to make a map that is useful and easy to use by the map reader.
  - b. The second map is a location (tourist) map for a park and reserve of Marsabit region in Kenya (marked as 3a, 3b, and 3c in Figure 1 below). The objective of this map is again focused on what map components are necessary to include in the map and what map components are not needed, as well as what to look for in title wording in relationship to the map content and its objective. The objective is also to make a map that is useful and easy to use by the map reader.
3. The last map is a choropleth map of South America (marked as map 4 in Figure 1 below). With this map exercise, students are introduced to the concepts of statistical mapping and the different classification methods that are available for them in ArcGIS. Students are given the choice to create a final map with a single topic or with multiple topics,

While the maps used for this course do not represent the thousands of applications that GIS analysts might use this software for, however, the concepts behind the course exercises can be universal and applied to variety of maps regardless of the discipline.

Three types of critiquing were used in this course:

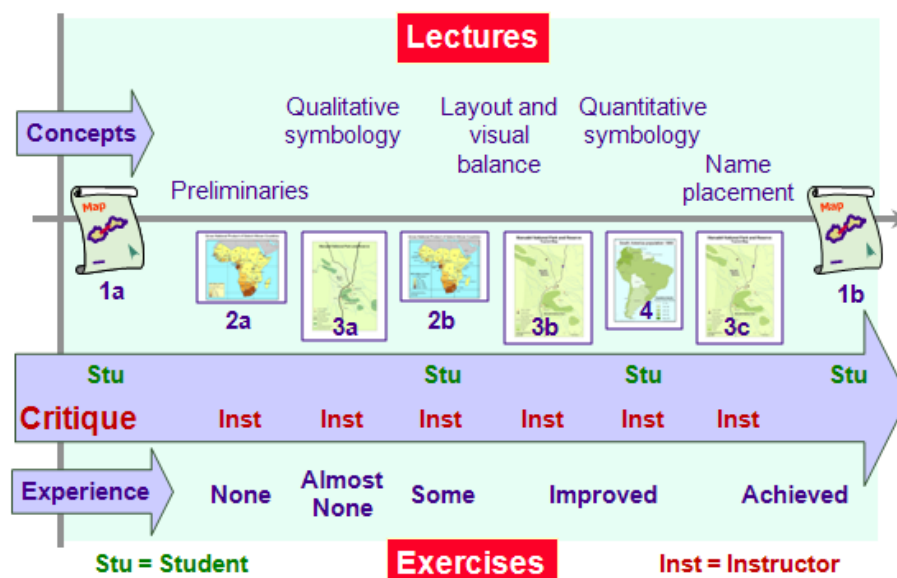


Figure 1 – Proposed course model

### 1. *Student critique – Type 1*

An existing map is supplied by the instructor in paper form (an online map can also be used but in some instances Internet connection can be a problem). See maps 1a and 1b in Figure 1). This map is critiqued by the students at the onset of the course using a specially designed map critique checklist (Murad-al-shaikh, 2003). The objective of this first critique is to stimulate the students on what terminology is used and get exposed to how others have designed their maps. At the end of the course, students are given the same map to re-critique based on the same checklist and discover how much knowledge and experience in cartographic design they have achieved in this course. The maps that are used for this critique exercise have different topics and design than any of the maps that students are supposed to create and critiques in this course.

### 2. *Instructor critique*

As the course progresses, students create three maps without any self critique. These are maps 2a, 3a, and 4 in Figure 1. Students will receive a detailed critique from the instructor directly on these printed maps. Critique will include acknowledging the good aspects of their design as well as constructive critique of the bad aspects of their design with enhancement suggestions.

### 3. *Student critique – Type 2*

As the course progresses and students get exposure to more cartographic concepts together with the written critiques received from their instructor, they will redesign and improve their maps in later exercises (these are maps 2b, 3b, and 3c in Figure 1). They are also requested to present a paragraph of their design concept and corrections that they have applied in their map. In a way this can be looked at as a self critique of their map design. The idea of the students writing this paragraph is to help them learn how to articulate their design and to keep this document with their map since they would have to review before enhancing it for the next exercise.

Each map receives a grade that accumulates to form the student's achievement in the applied portion of the final student's grade.

While group critiquing of a map is very useful, one would not want to embarrass any student with having his or her map be displayed and critiqued in public. Instead of this practice, few of the lecture slides were designed to show some maps specifically created by the instructor to demonstrate the proper concepts pertinent to the lecture sequence within the course. Students can be motivated to participate in discussing the good and bad aspect of the design in such maps.

#### *The final written exam:*

The final exam is made up of two parts: The *written exam* and the *map critique*. As for the *written exam*, it must be designed to reflect if the students have captured the cartographic design concepts and, more importantly, can apply it. Essay questions might not show nor prove if the students can really apply what they have learned

throughout the course. So, a combination of True/False questions as well as graphic questions seems more appropriate. Graphic questions can be in the form of giving them some graphics and are asked to improve it using certain cartographic concepts. For example, how does one create different visual levels from a bunch of drawn lines? See Figure 2 below.

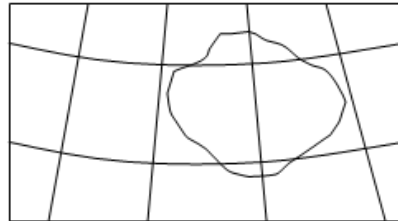


Figure 2 – An example of a graphic in a sample written exam.

Written exams can be either done by manually or via a computer. If a hand written exam is used, one is not to expect students to have artistic hands but can simply demonstrate that they understand the concept with any simple graphics that they can apply to answer the question.

*The map critique exam:*

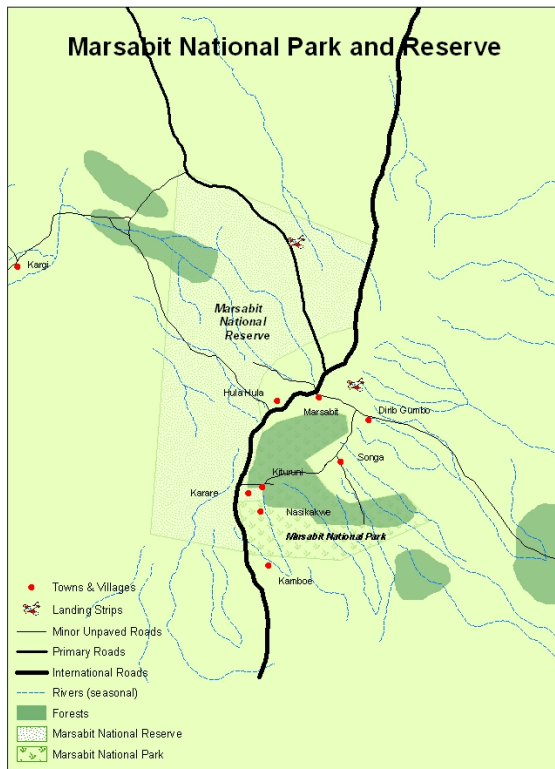
As mentioned above under the *Student critique – Type 1* item, that at the end of the course, students are given the same map they critiqued at the onset of the course to re-critique it. This part of the exam give students the chance to evaluate their learning experience and shows how their eyes have improved in the way they look at maps. In fact many students told the author after they graduated that they now have a different way of looking at maps than before.

Table 2 shows how the grades are divided for students.

|   | <b>Number of points</b> |
|---|-------------------------|
| Final written exam  | 300                     |
| Final map critique exam*  | 100                     |
| Map exercises (6 maps)  | 120 or 140**            |
| <b>TOTAL points possible</b>  | <b>520 or 540**</b>     |
| *Refers to both 1a and 1b in Figure 1                                   |                         |
| **Can add an exercise on calculating and designing a scale bar manually |                         |

Table 2 – Example of how student grades are calculated.

Observing student maps over thirteen years using such a model as experienced by the author has demonstrated increased performance by the students. This was obvious from the maps they created. Figure 3 shows an example of two maps by the same student. The map on the left is the one he designed at phase 3a and the one at the right he designed at phase 3b (phases as referenced in Figure 1).



**Marsabit National Park and Reserve  
Tourist Map**

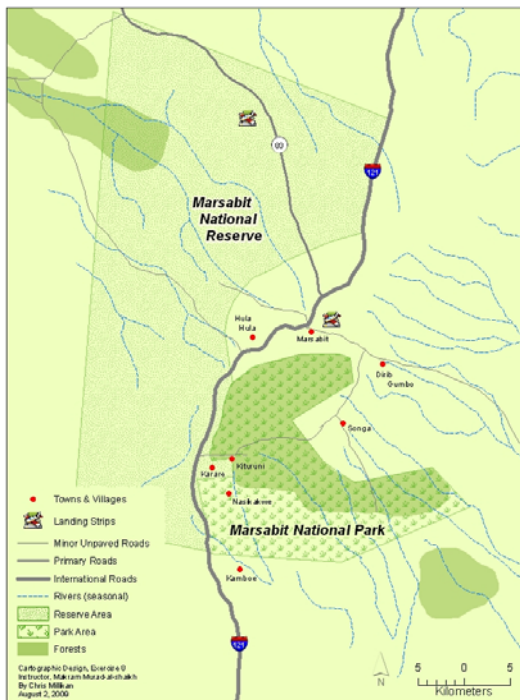


Figure 3 – Examples of a student’s progress throughout the course (Millikan, 2009).

While the map on the right shows better cartographic design application as compared to the one on the left that the student designed earlier in the course, it is obviously not final. In discussion with the student he recognized what still needs to be changed to enhance it.



As a final note, many of the author's students have sent other designed maps after graduation and working but unfortunately the author did not receive permissions to use them for inclusion in this paper for publication.

**Results and conclusion:** This paper has demonstrated that teaching GIS analysts a GIS cartography course can be different than teaching a traditional cartography course, and that a model for designing map critique exercises, the method of delivery, and evaluating students' performance and improvement as they proceed through the course is thus proposed for a GIS cartography course as outlined in the details listed. This method has proven to be very effective, and this paper proposes this method as a standard model for designing and teaching GIS cartography courses.

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### **Acknowledgements:**

Figure 3 shows two Marsabit maps designed by Chris Millikan, 2009, an author's student at the University of California – Riverside. Used with permission.