Map Use in Secure Web-based Instructional Environments

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Abstract

The author employs a web-based tool in the instruction of a large class which has a strong cartographic component. Students can access this tool only with a password so the content is not available to the public. The exclusion of the public gives greater freedom to show private content. The password limits the audience to a select group of students with a specific set of tasks. And, because the instructor monitors time spent on the system there is an added motivation for students to use the tool. For these reasons such web-based instructional tools can be considered a unique map use environment.

Maps in a textbook are static images designed to present knowns. While these same maps can be displayed on the web there is the opportunity to go beyond simple communication. In the cartographic visualization environment the user in private seeks to reveal unknowns by actively interacting with the map. Such web-based instruction can be designed to approach the visualization environment. And, on the web it is possible to employ color, animation and interactivity with the map.

In the visualization environment the user with the proper tools is likely to see things that others might not see. The concern in the instructional environment is to develop maps and interfaces to those maps so that students will see the things the instructor wants them to see and yet give the students the tools to see even more. The students should be able to gain more knowledge than simply that demanded by the instructor.

In the case of a secure web-based instructional environment we know who the users are. They get access to the environment for a specific purpose. We have the ability to monitor their use of the system. Because students know their performance will be monitored they have a motivation to participate and perform. In this paper the focus is on the creation of environments in which students are motivated to explore maps online with multi-objective outcomes. The emphasis is on world maps but the content ranges through a variety of scales.

Introduction

The many dimensions of map use has been my focus for many years. Much of this work related to the work of the late ICA Map Use Commission. Recently I was challenged to develop the course "Earths Dynamic Weather" to be taught to a large group of general education students with little knowledge of geography. Concurrently, web-based courses were coming to the fore and the resources of my university permitted me to consider building a course on the web. I chose to use WebCT as the web-based testing program because expertise would be available if I needed it.

In addition, I became aware of web-based maps of weather (SSEC) and climate (FAO) that influenced the way I would design the course. I secured permission to use those maps. I worked with a graduate student in Applied Computer Science to develop some routines.

At the 1999 ICA Conference in Ottawa I reported on my plans to develop the new weather course. (Carter, 1999) I proposed to introduce students to the nature of the spherical Earth as it relates to weather and climate as a foundation for the study of weather. The use of maps and the development of cartographic literacy have been the major part of that foundation.

As of this writing the course is completed in WebCT and more than 500 students have worked through the material. This is a work in progress. The purpose of this paper is to share my findings, project on future plans and to plead for help in shaping future developments of the use of maps in this teaching environment.

The map use environment

One of the dimensions of map use is the environment in which the map is viewed. The traditional way to produce maps is ink on paper. Such maps appear in books and atlases, as well as separates. Users can linger over paper maps for they have total control of the map use environment. By contrast there are other map use environments where the interface between the user and map is quite different from that of the printed map.

The use of WebCT as the package to present my weather course represents a unique use environment. WebCT is one of a number of commercial packages designed to provide a collection of tools for the instructor to interact with students via the web. I do not have personal experience with other packages so all comments are based on my experience with WebCT. I assume the basic capabilities of this package can be found incompetitive packages.

These packages provide the instructor with the tools to present web pages to the students in a secure environment. Thus, only persons set up with a logon and a password can gain access to the content of the pages. This exclusivity gives the owner of the site the power to show content that would not be appropriate on a public site. This aspect of the web environment is the focus of this paper.

There are other tools in these packages that are worthy of note, although they do not relate directly to the map use environment. The package can be used to present information to each student on his or her performance in the course. Within four days of completing an exam, I post the exam grades online. Each student can see only his or her grade. There is a calendar in the package on which the instructor can post assignments and comments related to specific dates. There is also a count that approximates the amount of time the student spent working through the material. I have been able to use the count as a means to motivate students to systematically work through the content material of the course.

There are two testing environments built into this package. In the Self-Test environment students are given multiple choice quizzes. The instructor writes questions and provides comments in the answers. These quizzes are designed to challenge the student and then give immediate feedback on right and wrong answers. The results of these quizzes are not recorded. In the other testing environment there are a variety of types of tests and the scores on the tests are recorded. This environment is designed so that the instructor can give examinations online. In my campus environment there is no computer facility where I can be assured that the student taking a test for credit is the student who should be taking that test. Likewise, without the proper accommodations I cannot be assured that the student is taking the test without books or other aides. Because I do not have access to a secure testing environment I do not make use of the graded testing capabilities of this package. I believe something is lost because of this.

In summary, this package provides me an environment where I can present web pages that can be seen only by those persons I authorize to see them, give quizzes with immediate feedback on the answers given, and provide a motivation for students to systematically work through the material by getting a record on their time on the system. The challenge has been to develop content that takes advantage of this unique environment. The focus of this paper is limited to the cartographic aspects of the course.

Mapping the Spherical World

To understand the global nature of weather and climate one must have knowledge of Earth as a rotating sphere. My students have little concept of the nature of our spherical world, so attention is given early in the course to establishing this foundation. Most students in the U.S. are exposed primarily to the areally distorted Mercator Projection.

The textbook (Ahrens, 2000) adopted for the course does little to counter the distorted images and uses the Mercator Projection for a number of world maps. I employ two sets of world maps in the WebCT material—one based on the equirectangular Platte Carree and the other on the Molleweide projections. And, in the text the students see the occasional Azimuthal projection centered over a pole. So, one portion of the WebCT material is designed to give a realistic image of the world for the student who will see images of the world on equal-area polar and Molleweide projections and on areally distorted equirectangular and Mercator projections.

Early in the course the students are introduced to the portions of the Earth that lie in the low, middle and high latitudes. We use these terms quite casually in terms of weather. For this course I make the distinction of 0°to 30° defines the Low Latitudes

> Low latitudes from 0° to 30° latitude make up 50% of the Earth surface
> Middle latitudes from 30° to 60° latitude make up 37% of the Earth surface
> High latitudes from 60° to the poles make up 13% of the Earth surface

Expecting the students to memorize these proportions helps them see the exaggerations in the equirectangular Platte Carree and Mercator projections. Equal-area polar projections and a Molleweide projection are employed to show the correct proportions of latitudinal areas and counter the distortions of the rectangular maps.

Later in the course the Tropics of Cancer and Capricorn and the Arctic and Antarctic Circles are introduced. At that time a comparable effort is expended to force the students to recognize what proportion of Earth's surface lies within the Tropics (40%) and what proportion lies poleward of the Circles (8%). Again, the common rectangular map projections belie these proportions.

Note that in terms of weather and climate these proportions are important for projections are that with global warming much of the heating will take place at the high latitudes. People need to understand that the high latitudes are but a small portion of the Earth's surface. How many of us readily think of the Low Latitudes as covering about 4 times the area of the High Latitudes?

The discussion on map projections is not influenced by working in a secure environment, other than it gives me freedom to show maps from the textbook. I would not be comfortable showing many of the maps from the textbook on a public site.

Instructing on How to Read Maps

In the ideal environment I would create a collection of maps that would be perfect to show the content I want to convey to the students. But, reality prevails and I have chosen to use maps that already exist. So, I took on the task of instructing the students on how to read these maps. In the process I point out the strength and weaknesses of the maps, with one goal being the building of cartographic literacy in these students. Hopefully, after working through this material each student will be more sensitive to projections, class intervals and the employment of colors on maps. Because I am working in a secure environment I feel comfortable making criticisms of the maps I employ. I am not comfortable making such criticisms on a public site.

The FAO world maps of temperature and precipitation consist of a map of average annual temperature and a map of average annual precipitation as well as individual maps of each of the 12 months. These are based on observed terrestrial values derived from a global dataset. (Leemans and Cramer) For both temperature and precipitation there are animated GIF files of the 12 monthly maps making loops that cycle continuously. Both sets of maps employ 14 levels, differentiated by colors. The authors of the maps have tried to create a graded series of colors but creating a series of 14 colors is very difficult. The result is mixed. So, one thing noted is an evaluation of how well their color series represents a graded series and why it is important to have a good color scheme.

The legend of these maps of temperature is common to all of the maps in the series. The class divisions in the legend are indicated only between every other color step. The classes at the extremes are open-ended. Interestingly, the range between class limits are not uniform. I can find no logic in the choice of class divisions, so I conclude:

> "The steps in the legend of this map are not logical, but this is what came with the maps. These are useful maps so we will learn to live with the illogical legend steps."

Figure 1 is the FAO map of Average January Temperature. On the map these colors form a fairly good graded series. However, the light gray color in the legend does not appear on the map. This is worthy of note.

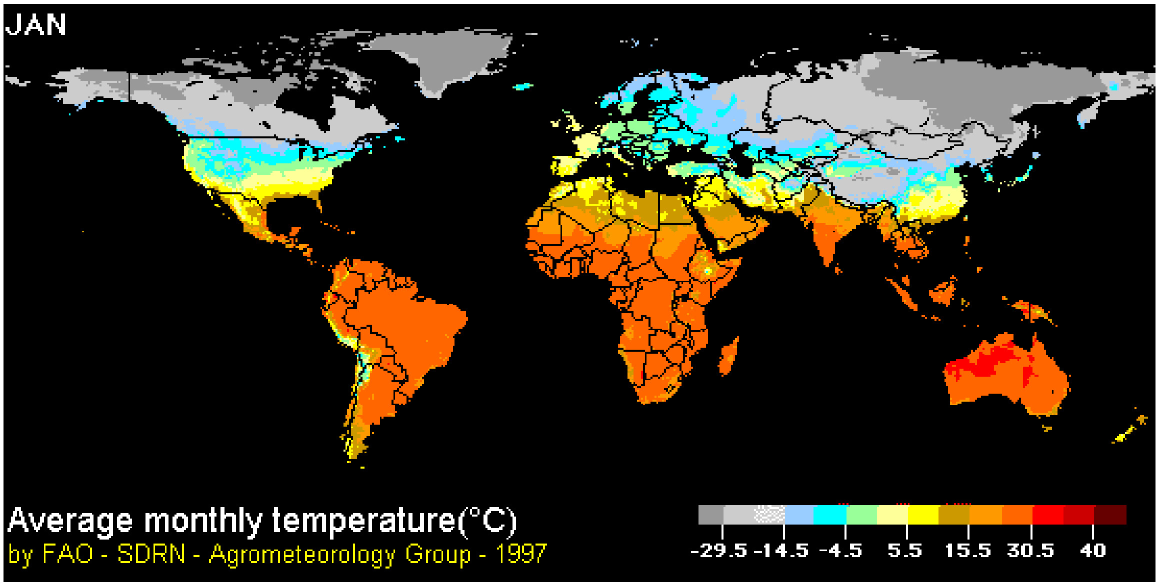

Fig. 1 – Example of the FAO-SDRN climate maps. Such maps of temperature and precipitation are employed in the weather course.

The textbook (Ahrens, 2000) has only one map of global temperature, but it is much different from the FAO maps. It portrays for land and water average annual temperature reduced to sea level. As such there is no effect of elevation shown on the map. It is on the Mercator projection extending between 80° North and South. The color scheme on this map is graded but it is far from ideal. And, rather than using a separate legend on this map the isotherms are labeled.

Helping students compare these two ways of portraying global temperatures has value in the study of climate but it may be more important in helping the students develop map literacy. If students understand the differences in what aspect of temperature these two maps show and how the projections and symbology affect the representation of temperature, we should be pleased. The task is to present the maps and pose questions using the maps to facilitate the education of these many students.

In the self-test the students are called upon to read the maps and answer questions based on their ability to visualize classes and use the legend. Figure 2 shows a self-test question where students are challenged to determine differences in continental and marine environments at the same latitude.

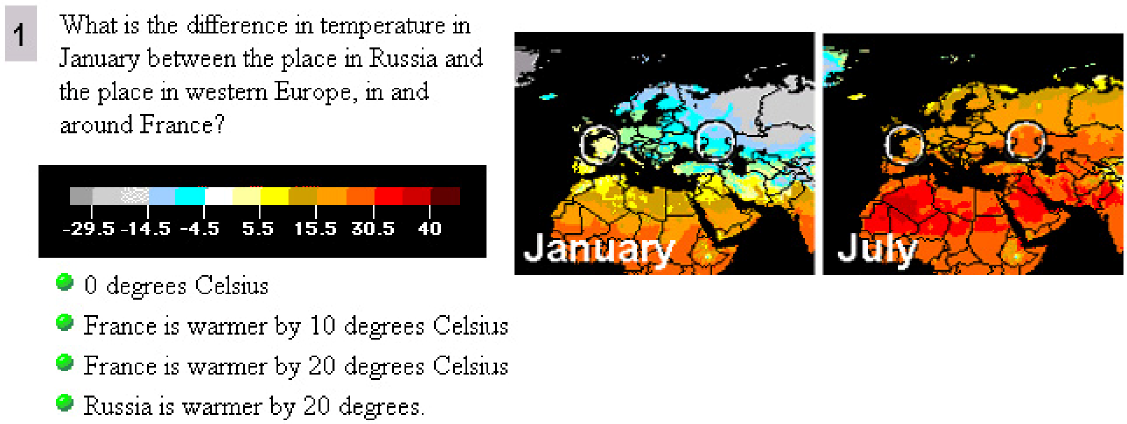

Fig. 2 – A self-test question asking students to use the map legend to determine specific temperatures. Students get immediate feedback after selecting an answer.

The FAO maps portray observed temperatures so they reflect the influence of elevation. To emphasize the effect of elevation a map of elevation was created on the same projection using an online interactive tool. (LDEO, 2001) Figure 3 shows clips of South America from the FAO average annual temperature map and my LDEO map of elevation. These two maps illustrate the influence of elevation on temperature patterns.

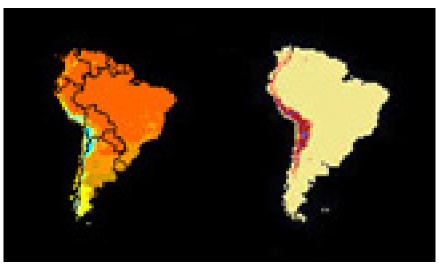

Fig. 3 – Comparison of a map of elevation with a temperature map to show the effects of elevation

Mapping world patterns of precipitation is central to the study of weather and climate. It is critical that students understand the need to distinguish small differences in precipitation at the dry end of the scale and use much larger classes at the wet end of the scale. And, a good graded series of colors is needed to show gradients. Surprisingly, many maps of world precipitation do a poor job of meeting these demands.

The FAO maps of precipitation employ 14 classes with the inherent problem of representing that many classes. The FAO precipitation maps employ that type of scale, although only every other color break is labeled in the legends. There are basically four colors in the graded series—grays, oranges, greens and purples. Figure 4.

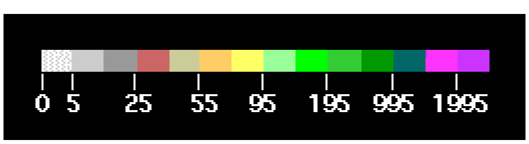

Fig. 4 – Legend of the FAO maps of precipitation

The two purple classes represent the extremes that occur in small areas, but I can find no purple on any of the monthly maps. On some of the maps I have removed the purple from the legend. Without the purples there are 12 colors, which are workable. The map of world precipitation in the textbook (Ahrens, 2000) employs only five colors with data appropriately broken into a smaller category at the dry end of the scale. With only five colors it should be easier to create a good color gradation. Figure 5 shows the gradation of colors employed on the precipitation map in the text.

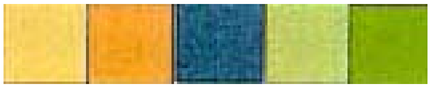

Fig. 5 – Sequence of colors portraying the precipitation gradients in the textbook

As shown above the five colors do not form a graded series. In my WebCT presentation I rearranged the colors to form a more logical series and present this sequence to the students. Figure 6.

Fig. 6 – Sequence of colors rearranged by the author to show a more effective precipitation gradient

I would not want to make these observations on a public site, but I feel comfortable doing this in on a secure site. I have suggested to the editor of the text that a better color sequence be used. I also found that one swatch of color is wrong on the African portion of the map in the text. Recently another edition of the text (Ahrens, 2001) was issued with the error repeated. Obviously, no one caught or reported that error. This makes me wonder how many people study maps enough to detect major errors?

The FAO maps include the animated sequence of the 12 monthly maps. Colleagues who are knowledgeable about climate greatly appreciate these maps and enjoy studying the animated sequences. Students and others ignorant of climate do not know enough to appreciate what they are observing and therefore do not know what to look at. After introducing the world maps and the animated map sequence, a number of maps are employed to focus on the dynamic patterns of selected areas. The north-south migration of the ITCZ and deserts over Africa are taken as the starting point, looking at January, April, July and October.

Rather than reading specific quantities, students are requested to focus on the areas that are relatively wet and dry and the intermediate areas. The color scheme permits this with the grays representing the dry, the greens the wet and the oranges the intermediate areas. In the series the wet to dry sequence of the Mediterranean climate is evident, if the person knows what to look for. These comparisons show that the significant differences are in the details. The educated person knows what is significant in such details. Getting students to see these details is part of the process of education.

Building on the pattern of precipitation in and around Africa a similar map story is told for south and east Asia and Australia. In this case portions of maps for January and July are employed, generally showing the extremes of the monsoon. Similarly, portions of the world maps are used to show the comparable shift of precipitation in the Americas. In all these investigations, a dynamic map of precipitation in the region is included following the discussion built on the static maps. Figure 7.

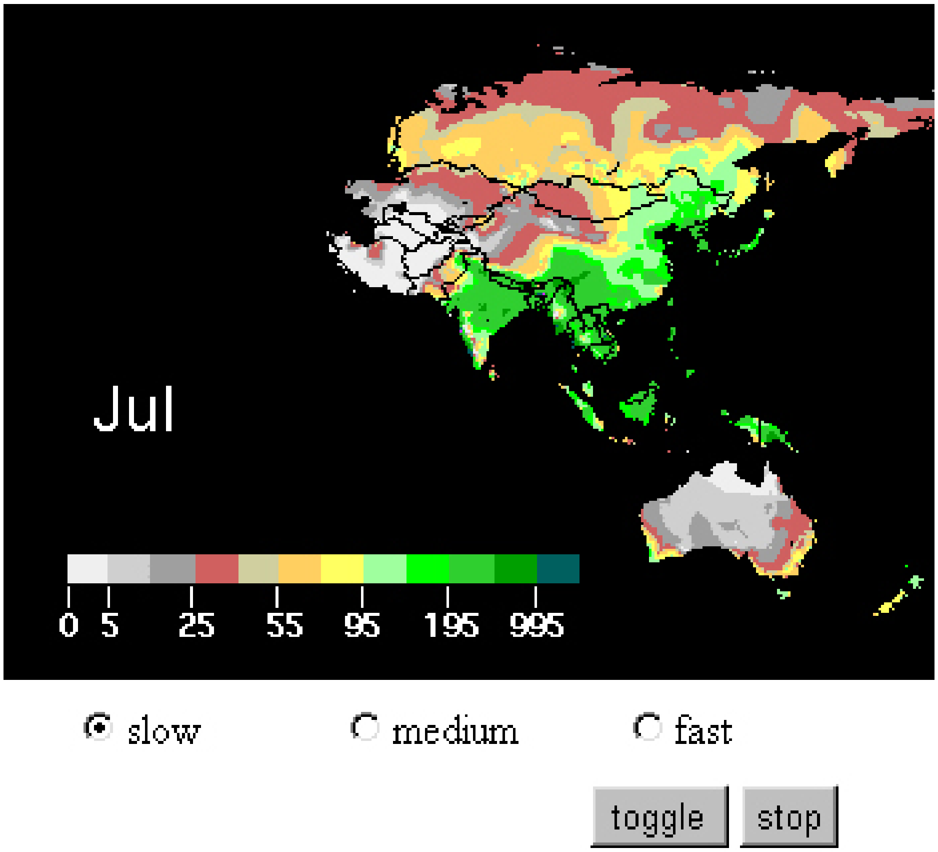

Fig. 7 - dynamic map for Asia showing precipitation for every third month. Students can control the rate the maps cycle through the loop or the student can toggle between maps.

Conclusion

These are examples of the maps and map interfaces presented in this course. The fact that the content is restricted to only students authorized to see the material gives freedom to present things not appropriate to be shown in public.

There are advantages and disadvantages in using a web-based testing program, such as WebCT. These packages are designed for a variety of applications and therefore must be flexible enough to accommodate all users. Maps and graphs are no different than text in the eyes of WebCT. There is space to insert text and if you want to show maps then that must be fit into that space.

The WebCT package offers many options and is quite fool proof. Rarely have students reported any problems in the operation of WebCT, which is a testimonial to the software. But, to achieve such performance the rules for adding and editing pages in WebCT are very specific. This is not a WYSIWYG environment.

Such packages are gaining acceptance in many academic environments. And, in coming years we can anticipate the evolution of web-based testing packages. These packages offer different map use environments and we need to learn how to design for and use these environments. Our students and other users expect the best from us.

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