Instructional aids or Wallpaper: A preliminary case study of science teachers' perceptions and use of wall posters in the classroom.

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Science organizations commonly utilize wall posters to communicate scientific concepts to students, teachers, and the public. This case study investigates the taken-for-granted good of posters through a survey of science teachers who received sample posters at 2 professional development workshops and in-depth interviews with 4 teachers. Interviews suggest teachers value posters to enhance classroom aesthetics by reducing sterility and contributing a "sciencey" feel. However, large quantities of explanatory text on posters limit their instructional usefulness to teachers. As a result, rates of poster use among participants were as low as 43%. While this is a preliminary study, clarifying ineffectual elements of sample posters and conceptualizing teachers' use of posters engenders potential for a new paradigm of instructionally astute posters.

Introduction

As a science education specialist working for the Incorporated Research Institutions for Seismology (IRIS) Consortium,[1] I came upon this project while editing an internal document that touted the distribution of more than 60,000 copies of a wall-poster since its development. What was striking was that I couldn't decide whether this was a successful or unsuccessful number. I had personally given that particular poster to many happy teachers who had waited in a long line to receive it. Had observed the poster in classrooms and hallways across the country and even been alerted to its appearance in popular media such as the science-fiction disaster film *The Core* and the teen drama television series The O.C. Clearly such experienced indicated that the poster was being used, but at what rate? Further, my prior experience as a classroom teacher made me wonder: Was the poster merely wallpaper for classrooms and advertising for our science organization and its field of research? Or, did it have some value in the educational process?

Education and outreach (E&O) efforts associated with government science organizations such as NASA, NOAA, USGS[2] and not-for-profit research consortia funded by the National Science Foundation routinely produce wall posters to communicate scientific concepts to teachers and their students, as well as the general public. Generally, these wall posters are artfully designed using figures, images, and text to both attract readers and communicate science content. Wall posters are most commonly disseminated at teacher professional conferences or teacher workshops, but public functions and scientific professional meetings are also distribution sites. To provide a sense of scale, NASA's Earth Observing System (EOS), a component of the Earth Science Division of NASA's Science Mission Directorate, produces a set of 4 educational

[1] The IRIS Consortium is a facility, funded through the National Science Foundation, comprising of over 110 research universities and institutions dedicated to monitoring the Earth and exploring its interior through the collection and distribution of seismological data.

[2] National Aeronautics & Space Administration, National Oceanic & Atmospheric Administration, United States Geologic Survey

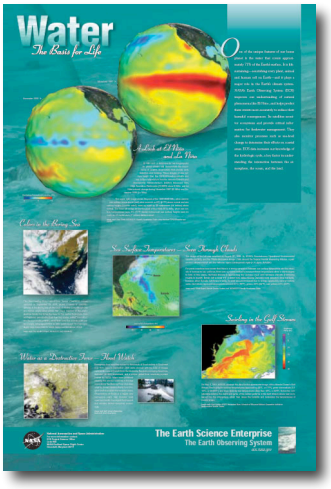

Figure 1: "Water" by NASA. Example wall poster produced by the science community

posters. According to the EOS website (2008), the "colorful and instructional satellite images, graphs, and pictures complement the fact-filled information making the posters ideal for the classroom" (Figure 1). Since the introduction of the series in 2002, the EOS project office estimates that over 100,000 of each poster in the series have been distributed at a variety of conferences and exhibits (S. Graham, personal communication, February 1, 2008).

The regular production and distribution of posters as part of E&O efforts suggests the science community believes posters to be and effective tool for conveying its message. Similarly, anecdotal observations of teachers waiting in long lines at conferences to receive posters and the nearly ubiquitous presence of such posters in science classrooms suggests a high demand for the posters from the science education community. While all parties seem content producing and consuming such wall posters, questions regarding the role and effectiveness of wall posters in the educational process exist. A review of the literature conducted in 2007 found no studies that directly examined the use of wall posters in the instructional process. However, the search did yield a small number of related studies that examined the influence of wall posters on employees in the workplace and the effectiveness of posters as part of public health campaigns. Informed by this related research on posters, this preliminary issue-focused case study investigates the taken-for-granted good of wall posters as tools for education and outreach and creates a space for conversation about current designs, effectiveness and possible improvement strategies.

The Preliminary Case

While there are hundreds of wall posters produced by the science community that could have been examined in this study, posters produced by the IRIS Consortium were selected out of both convenience and a sprit of continuous improvement within the IRIS education and outreach program. For full disclosure, I should clarify that I have not played a role in the development of the posters examined and have no stake in their success or failure other than a responsibility to ensure that the best possible products are offered through the program.

The IRIS E&O program has developed 5 different wall posters that communicate various aspects of seismology content (www.iris.edu/hq/publications/posters). Approximately 17,000 of these posters are distributed annually at no cost to the recipients (IRIS, 2007). While the E&O program does not define any specific audiences for these posters, primary and secondary audiences may be inferred by rates of distribution to various audiences. For example, 92% of the posters distributed in 2007 were to teachers of grades 6-12 via teacher workshops and professional conferences. An additional 6% went to college educators and scientists via professional meetings and conferences while the remainder were distributed to general audiences at public events. On average the development and production cost for an IRIS poster is estimated at roughly $10,000 of IRIS staff time, $5000 of time donated from the science community and $5000 for a print run of the first 5000 copies. These estimates include, a) time for staff, in

collaboration with several scientists to develop the scientific and visual content for a new poster, b) time for a graphics artist to design a layout for the poster, c) time for staff to collect feedback from the science community to ensure scientific accuracy, and d) time for IRIS staff to revise the design based on that feedback.

Methods

During the 2006-2007 school year IRIS supported 2 professional development workshops by providing 40 earth science teachers with 3 different content-aligned posters (see Appendix I). IRIS developed 2 of these posters and purchased the third from the USGS. Several months after the workshop, participants were requested to take part in an online survey assessing whether they used the posters and recruiting subjects for participation in the in-depth follow-up interviews. Two distributions of the online survey generated 14 responses and recruited 4 teachers to participate in the interviews. Not only did the surveys quantify the frequency of sample posters use, they also provided preliminary insights into teachers' conceptions of poster usage. Such information informed the development of themes used to structure the development interview guide for this synchronic report. Once developed, the interview guide was further refined through 2 pilot interviews with teachers who had previously participated in other workshops where IRIS posters were distributed. Pilot interviews, not included in the results, served to refine central questions of the interview and suggest new questions to establish meaningful conversations.

Semi-structured interviews with 3 male and 1 female high school teachers provided context for teachers' reported use or non-use of the wall posters, and contributed additional perceptions regarding the role posters play in the classroom and the learning process. All 4 subjects participating in the in-depth interviews were certified Earth science teachers teaching in 4 different school districts. Teaching experience among the group ranged widely: 1, 3, 7, and 38 years of experience. All teachers had masters degrees though 2 were in teaching (earth science) and the others were in geoscience. Three teachers had their own classroom while one teacher shared his classroom with another earth science teacher. All interviews with the teachers were recorded and fully transcribed. The interview material was analyzed using Weiss's (1994) 4-step approach to issue-focused analysis: coding, sorting, local integration and inclusive integration. Coding was completed by the author based both on categories brought to the study from background research and new categories defined and developed through interactions with the data. Next, excerpts of the coded transcripts were sorted around 10 central themes that emerged from the interviews: alternatives to posters, approach to posters (broadly), classroom atmosphere, challenges, construction, obtaining posters, maps, student learning and instructional strategies. Individual excerpts were then integrated within each theme to bring meaning to them and ultimately inclusively combined to produce the generalized issue-focused report below.

Findings and Discussion

Did the participants hang the sample posters?

The survey indicated that 13 of the 14 responding teachers displayed at least 1 of the 3 sample posters. Visits to 5 of these teachers' classrooms, including the one teacher who did not post any of the sample posters, verified the accuracy of this self-reporting. By examining this data for each poster individually, a variance in the frequency of posting emerges **(Table 1)**. In-depth

discussions with 4 of the teachers revealed 4 aspects of the most frequently hung poster that contributed to teachers' perception of its value and use.

Posters	(n)
This Dynamic Planet (TDP)	11
Exploring the Earth Using Seismology (EEUS)	7
A Century of Earthquakes (ACE)	6

Table 1: Number of teachers hanging each poster.

First, all teachers valued the aesthetics of the TDP poster. *"It's easy to see across a room and quite honestly, it's pretty."* Secondly, they valued the content of the poster and its alignment with their earth science curriculum. The TDP poster displays several major geophysics data sets including earthquake epicenters, locations of volcanoes, impact craters and vectors indicating rate and direction of tectonic plate motion. Third, teachers noted that compared to TDP, ACE had a significantly lower image-to-text ratio making the central image too small and the poster visually complex. *"Let's start negatively in the first one [ACE]- it's just so busy there… I couldn't use this that much*."

> *"The fact the posters have a lot of wording which they [student] can't see from their own seat is not really a problem. [However] the visual thing should be at least visual for, what do we have here, 15 feet?"*

Finally, teachers valued the TDP poster because it is also a highly detailed map of the world. *"I mean, it shows the plates for one thing… But because it's a map of the world it kind of serves me several purposes. If I want to walk over and say well, here's India or whatever, it's there."*

Teachers' preferences for posters that are attractive, simple with a clear purpose and use large imagery are closely aligned with attributes of effective posters non-school settings. Rege (1962) in a discussion of the use of advertising posters and safety posters in the workplace identifies 3 core attributes of effective posters:

- Attractive Power, or their ability to attract attention, identify themselves and be self-revealing,
- Communicative Power, or their ability to give a brief, simple message,
- Motivational Power, or their ability to appeal emotionally and create an impact.

Further, teachers' casual observations regarding the visual complexity caused by an abundance of text and small images align with our understanding of the way learners process and integrate knowledge from instructional materials. Cognitive Load Theory suggests a cognitive architecture comprised of a finite working memory that processes incoming information, and a unlimited long-term memory used to make sense of and give meaning (Kirschner, 2002). The working memory comprises two largely independent components that process visual and verbal information (Cook, 2006). While text is eventually transferred to the verbal working memory, it must be initially processed by the visual working memory causing competition with graphics for resources (Mayer et al., 2001). Since these two components function independently, instruction, in this case posters, have the potential of overwhelming the working memory by overwhelming either one of these components. Therefore, posters, like all visual representations, should be designed in a way that seeks to decrease the extraneous cognitive load and increase germane load when possible (Kalyuga et al., 2000; Paas & van Merrienboer, 1993).

One possible explanation for the substantial presence of text on posters produced by the science community is the community's tradition of producing and selecting images not to stand alone, but to highlight points and illustrate arguments that are being made in the text of a publication (Dumit, 2004). An additional influence may stem from the reasons the science community has Education and Outreach (E&O) programs. Posters are produced within the spirit of science E&O, where the science community have been encouraged to "communicate" their research to a broader audience (Rosendhal et al, 1995; NSF, 1996).

How do teachers perceive of and use posters in general?

Teachers value posters and perceive that they contribute to the educational process in 3 areas. First the presence of posters in a classroom contributes to the creation of a learning environment that is both visually stimulating and connected to course content. Second teachers also observed that when referenced during instruction, the visual aspect of a poster contributes positively to student conceptions of the abstract or novel phenomena covered in earth science classes, and stimulates student interest. Finally the presence of posters in the classroom provides on-topic mental escapes for students. The value of each of these 3 aspects was revealed when teachers were asked, which aspect would be most affected if they were no longer allowed to hang posters on the walls of their classrooms: a) the learning environment, b) their instruction, or c) self-directed student learning*?* All teachers immediately responded that that their learning environment would be greatly impacted if their administrations made such a decision. However, after thinking further, one teacher indicated that impacts to instruction would be become the top argument against the removal of posters. The remaining teachers, considered impacts to instruction to be secondary in importance, and none of them discussed impacts to self-directed student learning in relation to this question.

Posters and the classroom environment

When considering the role of posters in the classroom, all teachers expressed a need for the learning space to be comfortable for both the teacher and the students. To achieve this, they discussed a range of methods to alter the "soft" or aesthetic characteristics of a classroom. *"I'm big with classroom environment. I don't ever have my lights on except in the back because they bother me. I have curtains, which are above and beyond."* All teachers perceived that posters contributed positively to the creation of pleasing environments and avoided a feeling of sterility for both students and teachers. One teacher, who made no other references to altering his physical space except for using posters noted, *"It's not like this is a great room or anything, but you know what I'm saying? I think that those posters just add a little bit of something to the room."* Teachers expressed the belief that this "something" did not impact students' achievement but did hold the potential to impact their beliefs and attitudes.

If teachers simply wanted to create an aesthetically pleasing classroom it seems plausible that they might consider art prints rather than science posters. However, an examination of the their classrooms revealed a noticeable absence of such purely "pretty" posters. Instead the noteworthy presence of content-specific posters may be indicative of teachers' additional desire to create a content-specific, or "sciencey" environment.

> *"I think when you walk in the classroom, you want to have something that identifies the classroom with the subject matter there's rocks and globes all over the place. I think there's a certain atmosphere that would be lost by not having the posters."*

The value of a content-related atmosphere was not well articulated though comments suggest an attempt to reframe students' mindsets as they physically and mentally transition from their previous class. *"It's just four painted walls [like] a typical college classroom, which is serviced by every department and any department. I think the classroom has to have an expression of the individual and the subject you're teaching."*

Teachers' emphasis on the importance of altering their physical space to create a pleasant environment for both students and teachers parallels findings of researchers investigating the meanings of visual displays of student work in classrooms (Thomson et al., 2007). Further, teachers' beliefs about the impact of a pleasant space mirrors research on environmental factors and student achievement and behaviors. Researchers have concluded that the soft aspects of a classroom, such as climate, color palette of walls and wall decorations, lighting systems, noise levels, and seating do not directly affect student achievement. However, such aspects have been shown to have a positive influence on students' emotions and important effects on students' attitudes and behaviors such as attendance, class participation, and rapport with the instructor (Graetz, 2006; Horowitz & Otto, 1973; Sommer & Olsen, 1980; Wong et al., 1992). Laboratory research on the impact of wall posters in a work setting finds similar results. Stone and her colleagues (1993; 1998a; 1998b) concluded that college students' performance on office-related tasks (e.g. creative, filing, or computational) were not affected by either the presence or absence of a poster. However, the mere presence of a task-related poster for workers filing or computational tasks, and a scenic poster for creative tasks, resulted in increased perceptions of the pleasantness of the workspace and higher levels of reported task confidence.

Posters and the instructional process: Visual supports

The most direct application for posters during instruction is as a *"visual aid"* supporting instruction. Here, teachers are looking for a *"gross image"* of a *"simple concept"* that they *"can't get anywhere else." "I like to show students as many pictures of relevant material as I can throughout the course of the year."* Teachers valued such visuals because many perceived earth science content as presenting conceptual challenges to students. *"It [earth science] is so conceptual. Kids have such a hard time with the concepts without those visual aids.*"

When asked whether references to posters during instruction were planned or spontaneous, all teachers agreed that use is *"more random than it is planned"* and is frequently tied to student questions requiring an alternative explanation of a concept. *"Having the posters up on the wall has sparked several questions within lessons and it's, I think, giving them a deeper meaning for understanding what we're talking about."* Emphasizing the extent of this effect, one teacher even noted that even off-topic questions are a positive.

> *"Often in the middle of a lecture some kid's hand will go up and go 'that picture with the green lighty things, what's that?' It does get us off topic, but instantly everybody is engaged again. Even when I get back onto what I was talking about, you've still got them."*

While references to posters during instruction are random, teachers' comments suggest that spontaneous use is anticipated. All teachers discussed rotating their selection of posters *"based on what unit we're on"* to maintain connection to the content. For example,

> *"the pictures of the Earth from space were very relative at the time that we were talking about it, and I feel that, you know, it kind of ties everything in together, and now we're on rocks so the rock posters are very relevant."*

By keeping their posters aligned with the content they are covering teachers *"don't have to hunt for it (the poster)"* and prepare for such opportunities in advance, "*My maps are all on the side where the desks open, so it's very easy to twist around."* In all cases teachers viewed poster rotation as a way to introduce new content. This behavior was largely derived from teachers' personal perception that such a strategy positively supported their instruction. However in one case, a teacher explained that teachers in his building were strongly encouraged to apply this strategy in their classrooms by the building administration.

Using visuals to enhance instruction is commonplace in teacher-education courses and is viewed as best practice. While less common in teacher-education courses, the use of posters to call students' attention to upcoming topics and spark questions may be similar to the use of an introduction to well-crafted lecture. Such lectures are introduced in teacher-education courses as methods to motivate student attention and provide cues for what will be presented and emphasized (Chiappetta & Koballa, 2002). In fact, Henson (1998) concludes that one of the most effective uses of visual aids is where the "lesson is not pre-developed, but built up in front of the students who help develop the concepts."

Posters and the instructional process: Mental escapes

In a classroom setting there is significant competition for learners' limited cognitive resources. Thus learners may actively select to participate in the instruction or to focus their resources elsewhere, writing a note to a friend or completing an unfinished homework assignment. All the teachers in the study were aware that *"brains wander"* during instruction and strategically prepared this by using posters to provide content related opportunities for students' mental escapes. *"The stuff up front is all pictures of nature and earth science phenomena. I kind of put them up there because I see students, my screen is right in between them, and I see students sometimes wandering."*

Such practice is aligned with research that suggests that natural scenes such as windows, video loops and scenic posters serve a restorative function for workers and may provide stimulation for workers seeking information or cues (Collins, 1975; Kaplan, 1983; Stone, 1998a). While workers report that such scenic views, especially windows are highly desirable in this way (Markus, 1967; Jackson & Holmes, 1973; Butler & Biner, 1989; 1990), teachers want something more specific for their students' mental breaks. *"I want a kid to sit in the room when they're not with me, they're somewhere else, but focusing on science."* A few teachers left open the possibility that some self-directed student learning may occur during these mental breaks. *"They're sitting here and they're looking at that picture every single day. I think they're getting something from it."* Though, ambiguity exists in this opportunity. *"So are you going to leak something into their brain by using an alternative method of teaching in a sense? That is what I'm saying there."*

Posters and the instructional process: Student self-directed learning

Teachers' skepticism about the amount of self-directed student learning that occurs from posters may also be based on the basic operation of many public high schools. In many high schools students have 5 minutes or less to change classes. Along the way the trappings of modern-day adolescence distract and delay them. Upon reaching the classroom, teaching strategies such as bell-ringers or anticipatory sets encourage them to be seated and working by (if not before) the ringing of the late bell. As a result few students are likely to have adequate time to freely examine a poster. Further, explanatory text on posters is generally of a font size that makes it unreadable from student seating. Thomson et al. (2007) in an anthropological study of English elementary classrooms made similar observations regarding the use of classroom walls for self-directed learning.

This notion of posters having at best a limited value for self-directed learning is congruent with a small body of literature examining the effectiveness of wall posters found in the waiting rooms of physicians' offices. Similar to a classroom whose teacher has covered its walls with wall posters, waiting rooms frequently contain wall posters conveying information that physicians have selected with the specific intention of conveying information to their patients. Additionally, like students waiting for class to begin or daydreaming during class time, patients are free to manage their limited cognitive resources however they choose while waiting to be seen. Results from several studies examining whether patients looked at and could recall the topics of the posters were mixed and inconclusive (Ward & Hawthorne, 1994; Wicke et al., 1994; McGrath & Raymond, 2003) while a more rigorous study showed no statistically significant effect on patient behavior despite patient education that included the use of wall posters (Mead et al., 1995).

Conclusions and Implications

This small survey of teachers finds that the rates of use for the sample posters range from 78% to 42% depending on the poster. While such findings are not broadly generalizable due the scale of the survey, this finding is evocative because of the way the posters were distributed. In contrast with less intimate distribution methods such as booths at state or regional teacher conferences, these teachers received their posters after directly benefiting from a professional development workshop where personal connections to content and the sponsoring science organization were established. Therefore it seems plausible that these teachers would be more likely to hang the posters than those who received posters in a more anonymous fashion. Given that a significant majority of posters are distributed from booths at a variety of venues, this represents an area ripe for additional investigation to add further meaning to poster distribution numbers reported by E&O programs.

Teachers cited the construction of the sample posters as the primary factor influencing whether or not they hung them. From their perspective, non-use was frequently reflective of the poster's perceived usefulness and based largely on its overall construction. For example, teachers noted that sample posters EEUS and ACE contain a large quantity of text and smaller images, especially when compared to the sample poster TDP. Such visual complexity is a result of the completeness of content description suggesting that the science community views posters as stand-alone communicators of content. If this is the case, then to be effective not only must a poster be hung, individuals also must consume its contents. While this study did not directly examine whether students learned from posters, teachers reported a high degree of skepticism about its occurrence. Many cited as evidence the environmental factors such as competing

stimuli such as friends, iPods or instruction, as well as the limited free time that students have within the school structure to casually read a poster.

Perhaps more importantly, teachers noted that by designing *posters as the communicators of content*, poster producers inadvertently limited teachers' ability to use the posters as an aid to the *teacher communication content* in a classroom setting. Here teachers note that the relatively small size of the figures and the overall complexity of the poster made referencing many posters difficult. Despite such limitations teachers did report 2 simple strategies in which posters, beyond those in the sample, were used as during instruction. First, teachers used some posters with very large and clean figures to support the instructional process by serving as "*iconic*" and novel visual aids to the teachers as they explained concepts. Noting that such use frequently occurred in a spontaneous and organic way, teachers also rotated the posters in their classrooms to keep such visual aids aligned with the content being covered. Not only did this keep a stock of iconic visuals handy, it also is the second instructional strategy employed with wall posters. By rotating some or all of the wall posters in their classrooms teachers intentionally sought to signal shifts in content to their students. They believed such signals served to stimulate student thinking on new topics and spark questions while continuing to provide the material for on-topic mental escapes.

While this study suggests that posters, as currently conceived, do not play a significant role in the instructional process, insights into teachers' conceptions and use of posters create a potential for the medium of wall posters to be redefined. Especially in light of research suggesting that the effective capacity of the working memory can be increased if the cognitive load is divided across both the visual and verbal components through the use of both modalities e.g. *teachers as communicators of content* through visual images and the teachers voice rather than text (Kirschner, 2002; Mayer et al., 2001). In this new paradigm, posters would continue to meet teachers' current uses of posters by possessing the following qualities;

- an aesthetically pleasing design to support teachers' desire to enhance the educational setting,
- a transparent connection with the curriculum to enable a "sciencey" look and feel while supporting poster rotation as a method of introducing upcoming instruction,
- a reduction in extraneous content (both text and visuals) to decrease visual complexity while increasing space available for the germane iconic imagery.

Furthermore, to push posters beyond their current incarnation, they could be designed in a way that purposefully accounts for learning as a cognitively active process requiring the student's engagement (Bransford et. al, 2000). For example, a poster could use graphics to create an attention-getting visual analogies or thought-provoking "discrepant" imagery that would puzzle the observers and leaving them at a loss to explain what they have seen and desiring connections to the content (Piaget, 1971). Restructuring posters around these instructional strategies would allow teachers to integrate posters more meaningfully into their instruction. Since teachers draw on their own resources and capacities to read, interpret, evaluate and adapt curricular materials (Remillard, 2005), this effect could be further enhanced by including an online teachers guide that includes both explanatory text and specific information to support teachers' decision making and encourage teachers' development of flexible knowledge (Davis & Krajcik, 2005). For example, in addition to discussing the scientific content of the poster, such a guide might also

explore the complexities of visual literacy (Randhawa & Coffman, 1978; Goldsmith, 1984; Schiffman, 1995).

Having captured students' attention with imagery, a poster could further facilitate such engagement if it contained a prominent and simple URL. Such abilities would offer further engagement by overcoming the static nature of posters and extending the learning experience beyond the classroom in the more dynamic media of the web. Johnson (2003) suggests that classroom wall posters designed to both attract student attention and prominently feature a URL do have adequate presence to push students to a visit a website outside of school hours. Given that as of 2003, nearly 55% of US households have a personal computer or laptop and an internet connection at home; a rate that has grown at a rate of over 6% per year such an opportunity to extend learning experiences have never been more pronounced (U.S. Department of Commerce, 2004).

This issue-focused case study has provided insights into how teachers perceive and use wall-posters and suggested new approaches to redefining this medium to make it more useful in the classroom setting. However, the preliminary nature of this study leaves many broad lines of questioning to be explored through further research. These include: Are teachers' current strategies for wall-poster use effective at influencing student attitude and beliefs, as well as student learning**?** Can wall-posters be redesigned to enhance their usefulness to teachers? Could a website be used to extend the impact of wall-posters in the classroom?

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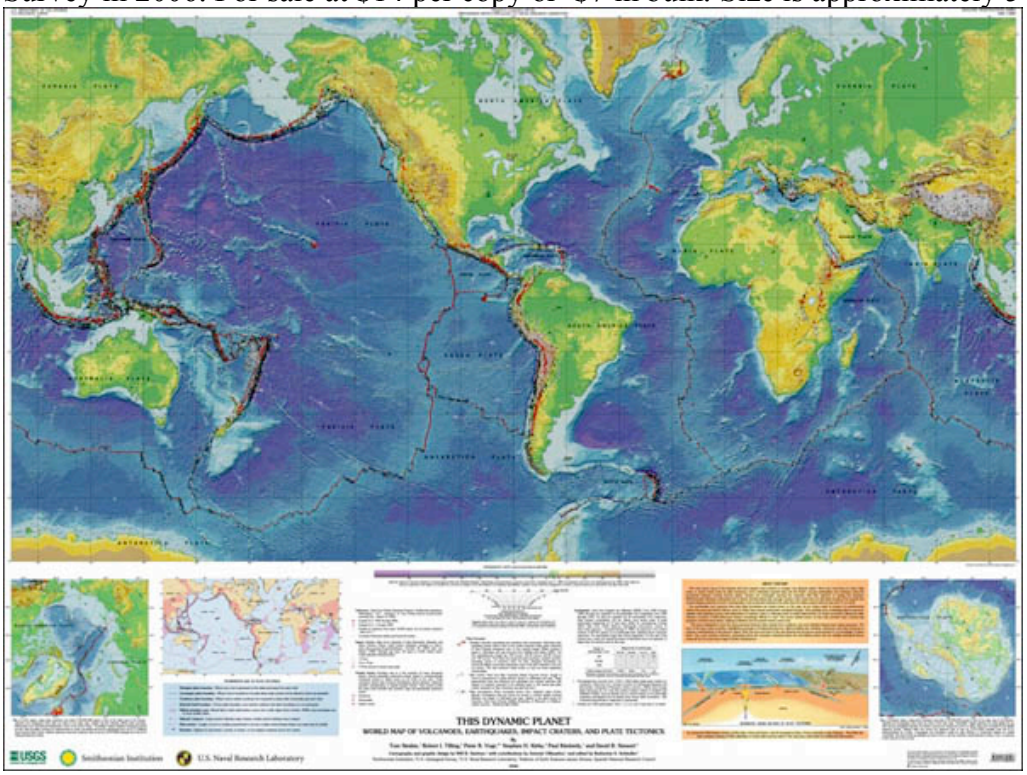
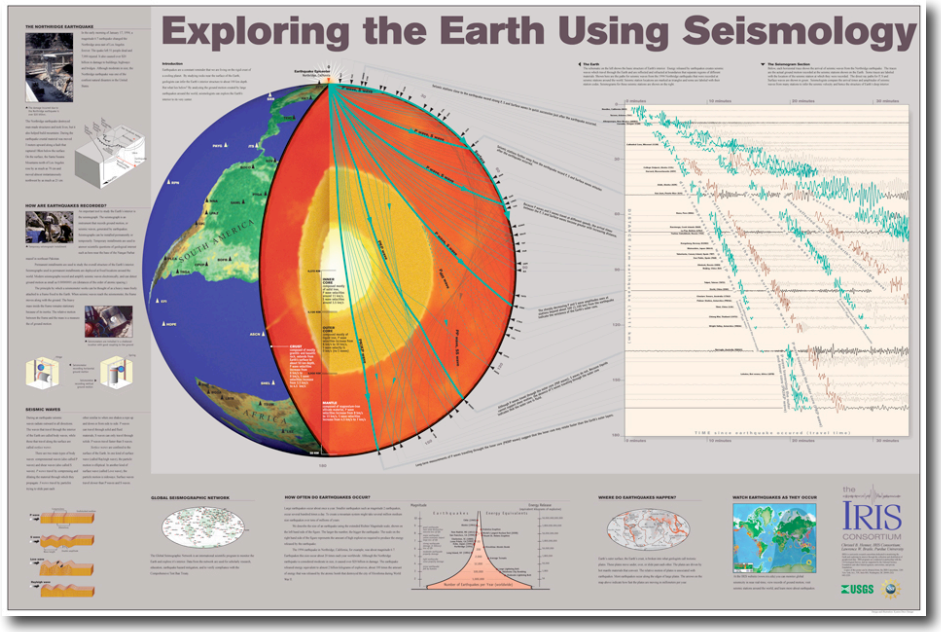
APPENDIX 1

Sample Poster 1: This Dynamic Planet (TDP) 3rd Edition. Produced by the U.S. Geological Survey in 2006. For sale at $14 per copy or $7 in bulk. Size is approximately 54 x 45 inches.



Sample Poster 2: Exploring the Earth Using Seismology (EEUS). Produced by the IRIS Consortium in 1998. Available for free. Size is approximately 39 x 26 inches.



Sample Poster 3: A Century of Earthquakes (ACE). Produced by the IRIS Consortium in 2007. Available for free. Size is approximately 39 x 26 inches.