CREATING ACADEMIC COMMUNITY FOR FIRST-GENERATION COLLEGE STUDENTS
A Graduate Student Instructor Guidebook

Grasping the Materiality of the Past: Digital Archaeology in Lower-Division Courses

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Archaeology is a material, embodied discipline; communicating this experience is critical to student success in lower-division courses. This article presents an overview and case study of how a digital approach to laboratory work can positively affect student learning. Virtual reconstruction serves, then, as an important bridge from traditional coursework to fieldwork. Highlighted curriculum samples include ill-defined problem sets, which help to scaffold students towards this fieldwork laboratory experience.

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1. Introduction

Archaeology can be defined as an "embodied, material activity" (Kyrsh, 2010, para. 1). Whether in the field or lab, researchers and professional archaeologists create theory and experimental methodologies to interact with ancient material culture. The materiality of this discipline resembles other fields in the sciences and social sciences, particularly medicine and biology, for instance. For this reason teaching World Heritage or Archaeology in a traditional classroom setting can be challenging, because hands-on activities are needed to understand difficult methodologies and theoretical passages on material data analysis. Moreover, there is a sensory and kinaesthetic element to a dig that cannot be replicated in the classroom. Archaeology, in fact, is not just theory: it is a direct contact with the ground, exciting and challenging at the same time. Archaeologists must learn to work with a team in a specific location and expertly use archaeological tools to avoid irreversibly damaging ancient material culture.

Communicating the materiality of archaeology is especially important when working with students in introductory classes. Their initial knowledge of archaeology and archaeologists is, in fact, stereotypical; it is based on legendary, representations of film and fiction. Contrary to popular myth, archaeological interpretation needs scrupulous scientific analysis with a multidisciplinary perspective, because the purpose of fieldwork is to use the scientific method to interpret cultural processes through artifacts, ecofacts and features found during the excavation. As a consequence, a team of specialized researchers (archaeo-botanists, archaeo-zoologists, experts on ceramics, physical anthropologists, professional diggers etc.) is fundamental for the analysis of material culture found during the excavation. The debate during this archaeological interpretation process is very complex, since some scholars argue that an objective treatment of data is impossible for the interpretation of cultural phenomena (Hodder, 1997; Hassan, 1997). According to this school of thought, called "post-processual" archaeology, the interpretation of past cultural phenomena is irreversibly influenced by our cultural background; in other words, the symbolism attached to material culture cannot be objectively understood.

To help students understand the topics explained in class, professors of *Introduction to Anthropological Archaeology* and *Introduction to World Heritage* engage them with problem-based learning (Huba, 2000, p. 37). Ill-defined problems are combined with realistic activities, and students are asked to apply theories learned in class and can demonstrate professional characteristics[1]. Although these assignments are very useful in archaeology, students cannot really experience all the steps that bring to a complete archaeological interpretation. In particular, they cannot fully understand fieldwork activities. Because of constraints like distance or economics, undergraduates going to an excavation can be an issue. Moreover students need to thoroughly understand all the steps related to archaeological fieldwork and research, before deciding to choose archaeology as their minor or major, and only then think about participating to a real fieldwork. For this reason virtual reconstructions of archaeological digs may be effectively used in lower division classes in order to provide the students a simulation of the archeological process. This digital reconstruction is conceived as a collaborative environment (Kurillo, Forte & Bajcsy, 2010, para. 1, 3; Forte & Pietroni, 2010, pp. 62-63; http://tele-immersion.citris-uc.org/sites/ti6.citris-uc.org/files/ti_archeology.wmv) where students can interact with the simulation of a real archaeological context, understand how archaeological research really works and interpret data collected by archaeologists in the field. The collaborative environment used in a lower-division class will allow all students to gain general appreciation for disciplinary conventions. An introduction to the profession enhances engagement and strengthens retention, which in lower-division courses is an ongoing challenge. For a sub-set, students could develop extra motivation for archaeology and decide to major in the field.

2. Technologies and learning: the virtual reconstruction of archaeological digs

I am working with a multidisciplinary team in an important heritage preservation and communication project. The project is aimed at documenting an archaeological excavation in three dimensions. In a few words, a 3D digital dig is a traditional excavation documented using three dimensional techniques (e.g. scanner lasers). The site that is going to be virtually documented is Çatalhöyük (Turkey), one of the oldest town in the world (http://www.catalhoyuk.com/);

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[1] Ill-defined problems and realistic activities are considered two of the main hallmarks of learner-centered teaching and assessment within constructivist learning processes. Constructivism is the fundamental learning process of human minds. Constructivism means that human minds actively create what they now. They have, in fact, the ability to interact with their environment seeking for meanings. (Huba, 2000, p. 37).

Neolithic town in south central Anatolia, which, in the 1960's, became the most celebrated Neolithic site in western Asia: for the complexity of its settlement, the mural paintings, and other symbolic elements telling the story of its inhabitants. The excavation is recognized as one of the most important in the world, and currently, Çatalhöyük is on the Turkish tentative list for UNESCO World Heritage Site inscription.

This excavation is the first time that a team of archaeologists have tried to recreate the digging process in three dimensions. The *3D digging at Çatalhöyük* summer 2010 campaign, directed by Maurizio Forte, allowed us to collect digital data that will be reconstructed and implemented in a virtual collaborative environment. A collaborative environment can be described as a virtual or cyber place where people can meet and interact for the creation of contents (Dell'Unto & Forte 2009). This reconstruction will be used in class to help students' understanding of archaeology. Moreover the fieldwork daily activities will be showed through video; stereoscopic images will give a sense of "immersivity" and encourage participation among the students. In this way digital technologies can increase motivation and persistence to 21st century students, or digital natives[2].

Recent studies show that students have frequent access to traditional technologies, such as computers, the internet, email, and mobile phones in everyday life (Waycott, Bennett, Kennedy, Dalgarno & Gray, 2010, p. 1206). Nonetheless they are more motivated to use technologies for personal rather than academic communication. 3D virtual reality and real-time video are also technological innovations that permeate young people's everyday life. Teenagers find immersive cinematographic experience at the movie theatre; they play the Wee and online multi-player games, known as MMORPGs (massively multiplayer online role-playing games). The latter have millions of followers, especially but not exclusively teenagers, since the users' age range is 11-68 (Yee, 2006a, p. 309). According to Nick Yee MMORPGs users play on line an average of 22 hours per week. He argued that "video games are blurring the boundaries between work and play very rapidly" (Yee, 2006b, p. 70).

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[2] The interest in contemporary students and their use of technologies is one of the main focuses of ECAR, Educause Center for Applied Research (http://www.educause.edu/), for example, a nonprofit association whose mission is to advance higher education by promoting the intelligent use of information technology. It is also at the center of one of the most important learning initiative by the Mac Arthur foundation, the Digital Media and Learning (http://www.macfound.org/site/c.lkLXJ8MQKrH/b.3599935/k.1648/John_D__Catherine_T_MacArthur_Foundation.htm).

MMORPGs are collaborative environments; thus students should be accustomed to working together. Through collaborative environments the students are transformed from passive observers to active stakeholders who provide contents. As a consequence, the use of collaborative environments in class could be an effective answer to the need of a new learning method in higher education, where technologies become central tools for transmitting and creating knowledge. Moreover technologies in this context could facilitate students' collaboration, and sharing of knowledge and ideas.

3. Learning outcomes. Real vs virtual lab activities

To some extent a 3D virtual archaeological dig can be similar to a conventional science laboratory at the introductory level. Through a virtual environment students can virtually understand a real archaeological context starting from its virtual reconstruction. The advantage of this experimental and innovative project is that it allows students to reflect on data collected during the fieldwork without losing the third dimension. The virtual reconstruction becomes a bridge to fieldwork and professional work that cannot be crossed otherwise. There are some limitations, though, such as the difficulty in activating a student's kinaesthetic intelligence. The materiality of archaeology starts from a set of gestures that researchers make to interact with material culture. As David Kirsh points out (2010, para. 2) the fieldwork, as any lab activity, gives to researchers the possibility to interact with objects and be able to simulate behaviours that past people could have with those objects; moreover, researchers can think with objects and try to interpret their function. Unfortunately the virtual world cannot offer a tangible experience yet, but in my opinion the material engagement does not have far to come.

In spite of the limitations discussed above, virtual reconstructions used in class reveal an important value for students' learning and retention. A study on virtual frog dissection, conducted in 2009, showed the effectiveness of this kind of virtual reality on high school students' learning outcomes (Lalley, Piotrowski, Battaglia, Brophy & Chugh, 2010). The authors compared virtual and real dissection and demonstrated that the virtual group of students learned more than the real one. Moreover, even though there were no differences in retention between the two groups, students could repeat the virtual experiment for improving their retention without any additional cost for the school. Also, as James Lalley and his colleagues argued (2010), retention is linked to practice;

through practice, the skills and information learned become automatic. Physical dissections are in general offered once, in one day, primarily because of economic and safety reasons. In addition to resolving possible ethical considerations, virtual dissections can be repeated at the student's convenience without additional costs (p. 196).

If a virtual reconstruction cannot activate a kinaesthetic intelligence, it can stimulate sensory-motor learning processes, complementary to textual or symbolic-reconstructive learning processes. The symbolic-reconstructive way to learn is based on texts that are conceived as symbols (Antinucci, 2004a, p. 17; 2004b). The students read and decode textual symbols and eventually recreate a visual idea from the textual description. In the sensory-motor learning process, they learn through perception and action about a historical reality; students perceive an event with the senses, act on objects and change the perception of the event after the action. This second process is augmentative: the action can be seen as a cause producing an effect, which is a new action. In other words the collaborative environment activates learning processes through affordances. The affordance is the quality of an object or an environment permitting to individuals to perform an action (Gibson, 1979). It is a stimulus for the brain to activate a constructivist learning process.

Another advantage of the virtual environment is the fact that students, virtually experiencing fieldwork, can understand what it means because they can grasp the materiality of archaeology. As a consequence, a student who chooses a major in World Heritage or Anthropological Archaeology could decide to engage in on site fieldwork, which, as already mentioned, is fundamental for developing professional skills.

When asked to discuss the limitations seen in the use of technologies in college, teachers often highlight fear to lose face-to-face interaction with students and obstacles in usability (Waycott et al., 2010, p. 1208). Instructors sometimes worry that the implementation of technologies inside colleges is more linked to technology itself than to pedagogic goals. A collaborative environment demonstrates the exact contrary effect with its main function being to facilitate analysis and discussions of content; in other words, it can be collaboratively used in class, where the teacher becomes tutor or guide for the embodied experience. Thus, a virtual environment can create more opportunities for interacting with students and engaging them in a learning-centered environment. Clearly, engagement and interactivity are key concepts for the integration of students in the academic context. This point is especially important for first generation students who often quit the university because of the difficulty of negotiating academic expectations (Kim & Sax, 2007, p. 12; Engle & Tinto, 2008, p. 3).

Digital learning and e-learning have been previously used at UC Merced in lower division classes. In 2008-2009, Nicolò Dell'Unto and Maurizio Forte, instructors respectively of *Introduction to World Heritage* and *Reconstructing Ancient Worlds*, planned courses in Second Life (SL) (Dell'Unto & Forte, 2009). Second Life is a cyber world constructed by its users, where they can meet, interact and organize activities, trade, etc., that is, live like in the real world. The online platform is used also for cultural projects, like virtual museums. UC Merced owns an island in SL (UCM Heritage Island) where users can visit 3D reconstructions of archaeological sites (Livia's Villa in Rome, for example). During the class undergraduates were invited to explore the cyber world and then, divided in groups, were asked to organize museum activities and exhibitions, presenting case-studies of World Heritage at risk. They could also build the exhibition place. The results were amazing: the students demonstrated a high level of concentration for the entire semester; the multiple levels of communication with the instructor, such as face-to face conversation, public chat, and private chat, increased the students' engagement (Dell'Unto & Forte, 2009, para. 3.1).

4. The case study

The summer 2010 archaeological dig, conducted by undergraduate, master, and graduate students of UC Merced, was an experimental adventure where traditional archaeological documentation was combined with a digital collection of data. At Çatalhöyük, archaeologists continue to use the stratigraphic method, which permits the creation of a relative chronology of the site during the excavation process (Harris, 1989). It is based on the *low of super position*, that is, the lowest layer deposited in the ground has been formed first. Every layer has to be considered as the result of a natural or cultural activity.

The digging phase is comprised of several basic steps: be able to recognize a layer, give an identification number to it, take pictures, draw it (making plans and profiles), and fill out a form, the *Stratigraphic Unit Record*, with information, descriptions, observations and a tentative interpretation of the unit. This time, during the fieldwork, the layers' digital scan was added to those steps. It was obtained using a non-contact triangulation laser scanner, the Minolta Vivid 910.

The UC Merced team dug the layers of an abandoned building whose original phase is dated back to the Calcolithic (or Copper Age). It was, thus, impossible to scan the building, because it was obliterated; therefore, it was decided to scan an adjacent building, whose original phase was already visible. The building was scanned using a time of flight laser scanner, the Trimble CX. A choice of the most representative artifacts found on site was also documented using the Next Engine desktop triangulation laser scanners. In addition to the digital documentation, photos and stereoscopic pictures were taken, and videos created.

The data thus collected will be useful for the creation of a digital application with educational purposes. I propose a study in which a class is divided, with some students using an ill-defined problem and others the virtual reconstruction. I want to compare how well students meet the learning outcomes.

In an ill-defined problem, in general, a text gives information on a realistic archaeological context; maps, plans, tables, with realistic data are given to the students, and they are asked to describe the data, and give an interpretation of the context (see the example in appendix). In the digital application the 2D material is substituted by 3D reconstructions of the archaeological context. The students will be able to interact with the 3D models of a real archaeological area; they will see UC Merced students at work in 3D, thanks to stereoscopic images; all the information on the site will be presented using different languages: texts will not be eliminated; they will become one of the means to explain the site in the virtual application (together with videos, audios etc.).

The final goal is to create a virtual system similar to the Virtual Museum of the ancient Via Flaminia (Forte, 2008). The Virtual Museum of the ancient Via Flaminia was created to musealize one of the most important roads constructed in Rome during the Republic (220 B.C.). The reconstruction is currently visible off-line, inside the National Museum of Rome –Terme di Diocleziano, and on-line, in UCM Heritage island, and at the address: http://www.vhlab.itabc.cnr.it/flaminia/index02.html. This application combines the reconstruction of the actual archaeological landscape, made through laser scanner technique, to the virtual simulation of the original villa. The application main part is the reconstruction of the Livia's Villa. Livia was wife to Augustus, first emperor of Rome (he died in 14^{th} A.C.). The story of Livia and of all the building phases is told using different media that can be activated as hyperlink, while navigating the system. The reconstruction is intended to be a virtual visit to the villa: the users, in fact, can choose their avatars, and walk around the site. Moreover, they can activate extra contents (texts, images, audios, videos) just clicking on 3D icons that they encounter in the landscape.

The main difference between the *Via Flaminia Project* and the *Çatalhöyük Project* is the final outcome: the first one was created, in fact, to musealize a monument and tell its story. The aim of the second project, instead, is to give to researchers and students the possibility to understand the archaeological stratigraphy and the excavation process in Çatal. In other words, the latter is more focused on communication of contents for insiders, while the first one was addressed to the general public. The Çatalhöyük application is not intended to tell the story of the settlement; it is more focused on teaching the archaeological process.

5. Conclusions

Research conducted to date has demonstrated the importance of technologies for learning outcomes. Digital Lab activities, such as VFrog or World Heritage communication projects on Second Life, show the value of technological advancement for higher education. They help in the creation of an interactive environment in class, and are particularly engaging for millennial students. Moreover they can be useful for recalling information and an effective alternative to hands-on activities, when the latter cannot be performed for economic or ethical issues. Digital labs brought into play in lower division classes give a new methodological approach for general knowledge retention, but can also help increasing motivation for the archaeological field.

As already discussed, it is important to stress the significance of collaborative environments as alternative to ill-defined realistic problems, in a problem-based learning environment. The virtual reconstruction of a real context can, in fact, be more engaging than a realistic reproduction of it. In other words, in a collaborative environment students can interact with the virtual reconstruction of a real archaeological context and try to interpret archaeological data as if they really were on site. Embodiment can be a new key for learning. The next step of this research will be to test a virtual environment in class, and try to demonstrate the value of this statement.

Appendix

Example of an ill-defined problem in anthropological archaeology; designed by Kathleen L. Hull, assistant professor of anthropology, for *Introduction to Anthropological Archaeology* (ANTH 003) at UC Merced.

ANTH 3 **Spring 2010**
ASSIGNMENT #8
Environment and Technology

Your research team is once again off on a new project, this time undertaking a study of the ancient environment of the Weigon Valley region in east Asia both as a context for understanding long-term regional culture change and environment as a product of human actions over shorter spans of time between 8000 and 4250 B.C. To help with the research, you have assembled a team of paleoenvironmental specialists, including a palynologist, a geomorphologist, and various faunal experts including an ichthyologist (i.e., fish), a malacologist (i.e., shellfish), and an expert in terrestrial mammals. Your ultimate goal is to: (1) reconstruct the local and regional environment over the approximate 4,000-year period for which paleoenvironmental data are available; (2) identify any significant environmental changes during that time; (3) determine the natural or cultural cause of such changes; and (4) explore the relationship of such shifts to the settlement and subsistence practices of the prehistoric inhabitants of the region.

The study area encompasses an upland valley located at approximately 3,000 feet in elevation and the adjoining foothills and mountain ranges, the highest of which rises to more than 7,000 feet in elevation (Map 1). The perennial Laize River flows from north to south through the Weigon Valley, with several seasonal tributaries feeding into the river along the way. Previous limited archaeological excavations at a few residential and non-residential sites in the valley and mountains to the west indicate that the earliest occupants were hunting and gathering people who lived primarily in the valley and exploited a variety of terrestrial mammals. Settlement shifted to more widespread use of the landscape somewhat later in time, although occupation focused in the valley again as people began to cultivate wheat and other grasses sometime before 4000 B.C. The archaeological record at this time includes evidence of grain storage and the construction of small mud brick houses that appear to have been single-family residences. For the current project, you have simply collected sediments from the base of two natural ponds (see Map 1) for pollen and charcoal analysis, and will use these data to help you decide where you might conduct future archaeological excavations to expand on your study. The major species represented in the pollen samples include:

- Pine, spruce, and fir – cone-bearing trees typical of dense forests in cold, dry climates
- Willow, alder, birch, and oak – deciduous, broad-leafed trees typical of open forests in cool, moist climates; oak acorns could have served as a foodstuff
- *Artemesia* species– perennial shrubs typical of open, steppe-like, cold, dry climates
- *Compositae* species – small, broad-leafed wildflowers and other similar annuals that occur in a variety of forest and meadow settings and climates; some provide edible greens or bulbs
- *Gramineae* species – various annual grasses that occur in open grasslands in a variety of settings, including some species that bear edible seeds or cultigens such as wheat

Figure 1 presents the relative quantities of pollen and charcoal frequencies from Pond #1 and Figure 2 presents the relative quantities of pollen and charcoal frequencies observed in the sample from Pond #2 (see Map 1).

You anticipate using site-catchment analysis as the model to guide your subsequent study of shifts in subsistence practices. You have been busy reading the literature on this subject, and have learned the following basic facts:

- People who make their living by hunting and gathering wild resources collected such floral and faunal resources within about a 2-hour walk of their village or camp site. This means that people will walk a maximum of about 10 km in any one direction from their residential site, but this distance decreases substantially if steep terrain or other factors (e.g., dense vegetation, rivers that cannot be crossed) prohibit movement.
- People who make their living primarily by growing domesticated plant resources will hunt or gather other floral or faunal species within only a 1-hour walk of their village or camp site. This means that people will walk a maximum of about 5 km in any one direction from their residential site. Again, this distance decreases substantially if steep terrain or other factors prohibit movement.

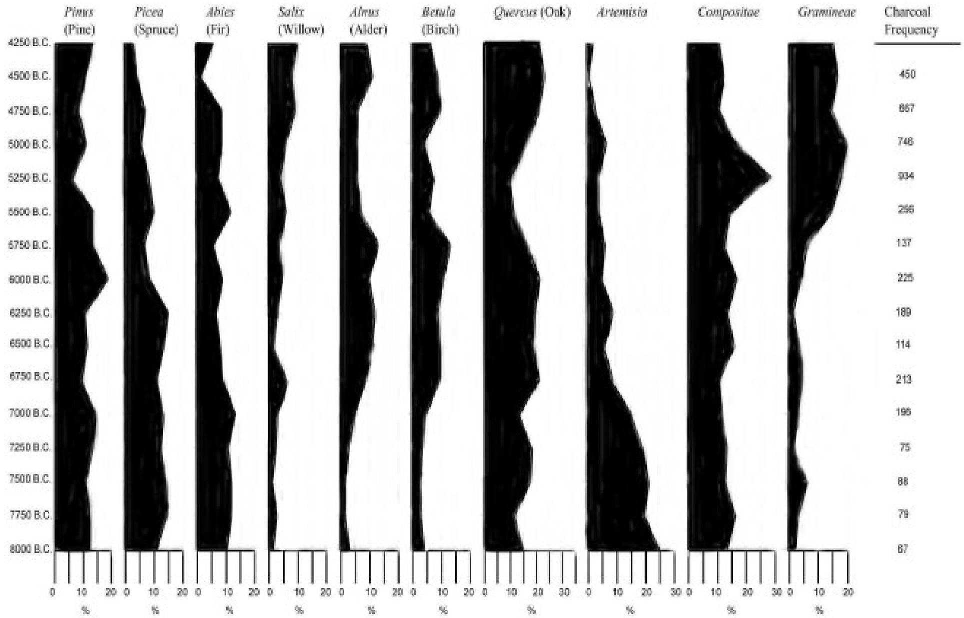


Figure 1. Relative representation of pollen types and charcoal frequencies for Pond #1.

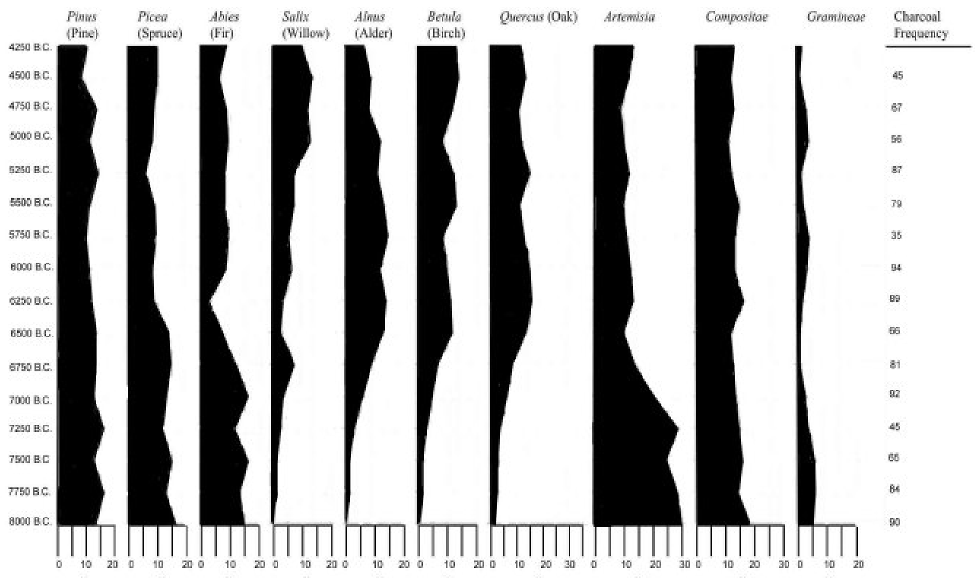
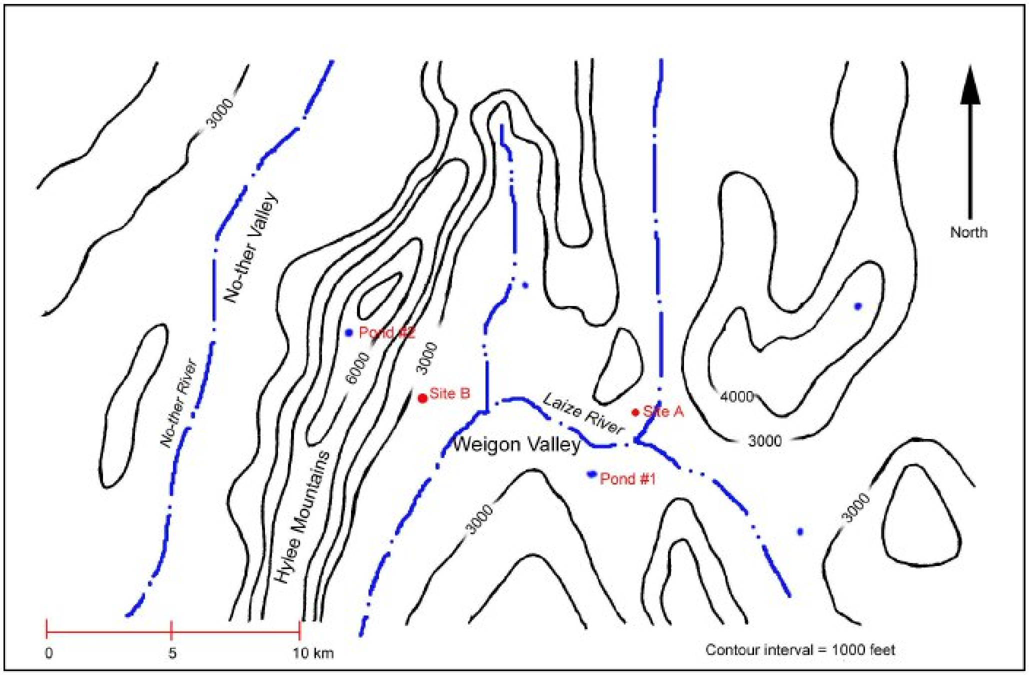


Figure 2. Relative representation of pollen types and charcoal frequencies for Pond #2.

ANTH 3 Name: ____

Assignment #8: Environment and Technology Section Day/Time________________________

Score: _______/6 pts



Map 1. Map of the Weigon Valley and surrounding area, indicating the location of pollen sample ponds and previously excavated archaeological sites.

Based on the introductory data presented above, in Map 1, and in Figures 1 and 2, answer the following questions.

1. The pollen data from Pond #1 indicate two significant vegetation changes, one at about 6800 B.C. and the other at about 5500 B.C. Describe both of the major vegetational shifts (i.e., changes in representation of particular species) that occur at each of these times. (1 pt)

2. Unlike the lower elevation pollen profile (Pond #1), the sample from Pond #2 shows only one major shift, although it is also at about 6800 B.C. Describe this major vegetational shift in terms of changes in species represented. (0.5 pt)

For the following questions, there is no one right answer, you must simply, just provide a clear argument backing up your answer.

3. Based on the vegetation shifts you have described in Questions 1 and 2, as well as the habitats and potential uses of the plant species involved, provide a well-founded interpretation regarding whether the shift at about 6800 B.C. reflects a natural or cultural phenomenon. (1 pt)

4. Based on the vegetation shifts you have described in Questions 1 and 2, as well as the habitats and potential uses of the plant species involved, provide a well-founded interpretation regarding whether the shift at about 5500 B.C. reflects a natural or cultural phenomenon. (0.5 pt)

5. Further work has been carried out to determine the frequency of charcoal fragments within the pond sediments (see Figures 1 and 2). Describe if and how these data correlate with either of the two vegetation shifts indicated by the pollen profiles and provide a possible natural or cultural explanation for the observed pattern that is consistent with your answers to Questions 3 and 4. (0.5 pt)

6. Reviewing reports of previous archaeological excavation in the Valley, you have identified two sites that appear particularly important to your research. Site A has deposits that date to about 6500 B.C., while Site B dates to about 5250 B.C. Based on what you know of (a) site-catchment analysis, (b) the terrain in the area as indicated by the contour lines on the topographic map, and (c) the shifts in vegetation through time (and your interpretation of the potential cultural significance of those shifts based on pollen and charcoal data), briefly discuss one reason why people may have relocated from Site A to Site B. (1.5 pt)

7. Given what you have learned about the environmental changes and what the site-catchment model tells you about land use by hunter-gatherers and agriculturalists, what additional archaeological data might you collect to help confirm the initial conclusions you have drawn from the pollen samples? Where might you look within the study area for such data (i.e., sites within the valley, mountains, etc.) and why? (1 pt)

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