AC 2008-979: BRIDGING THE HISTORICAL TECHNOLOGICAL GAP BETWEEN THE PAST AND THE PRESENT IN ENGINEERING TECHNOLOGY CURRICULUM

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Bridging the Historical Technological Gap Between the Past and the Present in Engineering Technology Curriculum

Abstract

In order to be able to compete in the worlds global economy, future engineering graduates need to have an understanding of the full road that technology has traveled on a worldwide basis. This paper addresses the advantages and dynamics of infusing hands-on historical-based engineering technologies into traditionally lecture based classroom situations. The project's overall goal was to increase the engineering student's awareness of technology's historical heritage and foundations.

The topics discussed include how historical skills, equipment, and knowledge were researched, remanufactured, and placed into a display format that brought students into personal contact with technologies from the past. By bringing the past into the present in a tangible format, students developed a more complete understanding of historical technologies along with the engineering challenges they presented, overcame, and all of the steps in between.

The results from this project indicate an increased student awareness, interest, and retention of just how technology has evolved. In addition, graduates of the Engineering Technology Program now have a better understanding of past technological issues that can be used to address future challenging and competitive situations.

Introduction

Engineering students are taught to design, develop, and build things of all sizes, shapes, and descriptions. In most cases, their objectives are to solve a problem, create a new product, or simply improve an old one. This has been the case for centuries; engineers have always faced these types of challenges. However, students rarely have the opportunity to look back into history and study how engineers and technologists from the past solved the critical problems of their time. They concentrate instead on using today's technologies in proven or new ways.

In order to fill this gap a new course was developed a number of years ago by the Engineering & Design Department at Eastern Washington University. It was titled: Technology in World Civilization (Loendorf[7], 2004) and was designed to broaden the students perspective of past technologies and how they were discovered and used. The main objectives of the course were to: (a) promote awareness of technological development, and (b) provide a rudimentary understanding of the social, political, economic, and cultural impact.

The content of this course explores innovations and inventions associated with ancient technologies, agriculture, weapons, time measurement, industrialization, transportation, communication, and the environment (Loendorf[7], 2004). These encompass every aspect of engineering and engineering technology including mechanical, electrical, industrial, civil, and environmental. By understanding the development, use, impact, and consequences of past technologies, students are better equipped to tackle the challenging problems the future will bring.

Initially the course was lecture and discussion based with a few videos included for variety. This format proved successful and the popularity of the course grew. Soon students from all disciplines across campus started enrolling in the course and it became apparent that the method of delivery had to be enhanced to suit this diverse audience. The engineering and technological focus of the course would not change, just the way the material was presented and delivered.

Active Learning

Active learning encompasses techniques that engage and connect students within the subject matter they are studying (Crawford, Saul, Mathews, & Makinster[4], 2005). This can be accomplished through discussion, interaction, application, demonstration, or knowledge as stated by Allen[1] (2002) and Tileston[9] (2007). Active learning is often also referred to as experiential learning, learning by doing, and interactive learning. Many positive learning outcomes have resulted from its use in the classroom as reported by Bonwell and Eison[2] (1991), Sousa[8] (1995), and Weimer[10] (1991).

Bonwell and Eison[2] (1991) defined active learning as "anything that involves students in doing things and thinking about the things they are doing" (p. 2). It is characterized by involvement rather than just listening, development of skills, higher order thinking, engagement in activities, and exploration of their attitudes (Bonwell & Eison[2], 1991, p. 2). By using controlled exercises and interventions active learning provides opportunities for involvement and interaction that is difficult to attain through traditional classroom activities.

The process of active learning transforms students from the role as a passive recipient of information just taking notes into a dynamic initiator of knowledge through participation. It has been shown that students learn more when they take an active part in the educational process (Davis[5], 1993). This can be facilitated through a variety of classroom exercises including interactive discussions, using ideas and concepts in practice, and actual application of the subject matter. This learning by doing approach requires participation, analysis, synthesis, evaluation, application, and reflection in terms of life, school, and work situations.

Active learning is far more than simply organizing activities for student participation. They must be clearly focused at specific objectives that either illustrate fundamental aspects of the subject or demonstrate vital processes. Active learning shifts the emphasis to student-centered activities from professor-centered activities requiring a different instructional methodology. After all, a critical aspect of education has always been making students the center of attention.

Recreating the Past

New visual aides were required to display how old and even ancient technologies worked along with more detailed explanations of their functionality. Innovative PowerPoint slides were developed to show the basic technologies, how they were used, and their evolution over time.

This change expanded how the material was covered and increased student awareness, understanding, and participation in the topics covered (DiSanza & Legge[6], 2005). However, this step was just the beginning of the improvements that could be made.

A way was needed to involve the students in a more dynamic, hands-on, and participative manner. The solution was to physically bring the technology to the students for them to touch, feel, and use in an active learning environment. Our project began by focusing on recreating the basic tools from the ancient past.

Modern technology has a vast volume of documentation that accompanies its creation; ancient technology is short on its documentation. As a result, one cannot just pull an ancient period book from the shelf and read about the then current technology from 10 to 20 thousand years ago. However, there are two prominent people, who have studied the history of the stone tool period and learned how to recreate the artifacts of that period. By using the reference material, researched and produced by Crabtree[3] (1972) and Whittaker[11] (1994), the process of building a set of Stone Age tools (refer to Figure 1) was started.

Figure 1. Stone Age tools.

To help with the classroom delivery of these newly created ancient tools, an AV cart was acquired, cleaned, and painted in a camouflage pattern. The individual items were numbered, placed in numbered clear plastic containers, and an inventory list (refer to Table 1) was then produced.

Table 1. Stone Age Tools Inventory List

Container#	Item#	Item Description
1	1	Medium Deer Antler
	2	Medium Striking Stone
	3	Medium Striking Stone
	4	Small Striking/Abrading Stone
	5	Medium Striking/Abrading Stone
	6	Medium Sanding/Shaping Stone
2	7	Large 2-Handed Chopping Stone
	8	Small 1-Handed Chopping Stone
3	9	Obsidian Chip
	10	Obsidian Chip
	11	Sample Bag, Mixed Chips and Flakes
	12	Sample Bag, Mixed Chips and Flakes
	13	Sample Bag, Mixed Chips and Flakes
	14	Sample Bag, Mixed Chips and Flakes
	15	Sample Bag, Mixed Chips and Flakes
4	16	Medium 3-Notched Boat Weight
	17	Medium 2-Notched Net Sinker
	18	Medium 3-Notched Net Sinker
5	19	Small Pestle (Natural Form)
	20	Small Digging Stone, Half Notched
	21	Small Digging Stone
6	22	Animal Skin Bag (Rabbit)
	23	Bone Awl
	24-39	Arrowhead Samples
7	40	Medium Hand Axe
	41	Medium Axe Head, Bottom Notched
	42	Small Notched Scraper With Handle

To further the students' understanding of this subject matter, a definition sheet (refer to Table 2) was assembled and used as a class handout. As each of the Stone Age Tools were demonstrated and discussed, terms from this handout were referenced. After visually seeing the tool in action, they were allowed to handle and closely examine each tool while referring to the definition list.

Table 2. Stone Age Tool Terminology

Abrading Stones- Naturally formed stones that contain an effective grit much like that of sandpaper or honing stones.

Arrowhead- Also referred to as a projectile point.

Barb- The long pointed edges that are found at the sides or ends of an arrowhead point.

Bird Points- Very small arrowheads, thought to be used for hunting birds. However, archeologists have found these type of arrowheads embedded in human bones.

Chips- Material that is usually considered to be the waste material that accumulates from the flint knapping process.

Core- Term referring to the “mother stone” which the workable pieces are removed from.

Direct Percussion- Method of directly striking the working stone with a striking stone or antler to remove large flakes.

Flake- A thin, broad and sharp piece of stone chipped from a larger working stone.

Flintknapping- The process of making stone tools. This process is considered to be a reduction process, as flakes of stone are broken off the stone that is being worked on.

Local Stone- Stone that the ancients would find within their normal range of travel.

Obsidian- Natural volcanic glass. Produces a chipped stone blade sharper than the most modern scalpels. Primary colors are black, grey, and mahogany.

Pestle- A stone tool used for pounding or grinding substances in a dished out stone.

Pressure Flaking- Method of placing a pointed tool on the edge of the working stone, and applying an inward pressure to the tool to remove small, thin flakes from the working stone.

Raking- Method of using an abrading stone to perform a working stones shape prior to percussion or pressure flaking.

Sinew- The shredded fibers of animal tendon, used for cordage, binding points on arrow shafts, and for backing material for bows.

Striking Stone- A stone that is used to strike or hit the working stone, similar to using a hammer. Also called a hammer stone.

Working Stone- The stone that is being shaped or formed into a specific tool.

To be successful in conveying to the students the set of skills required to manufacture these tools, it was necessary to learn how to make the tools. Then, starting with the basic flintknapping tools (refer to Figure 2), all of the rest of rest of the stone and bone items included in the Stone Age tool set was then created.

Figure 2. Basic flintknapping tools.

Beyond the basic understanding of how to manufacture these stone tools is an understanding of how and why they were used. Anchors and sinkers (refer to Figure 3), were used in the support of fishing, and the concept of their usage can be verbally explained. However, when a student can handle these items and can physically feel their weight and shape, they are better able to form an understanding of how they relate to their use in water.

Figure 3. Anchor and sinkers used for fishing.

The shape and size of the stones was very important. Groves or notches of various types and sizes were chipped into the stones to permit attachment of lines or nets. Sinker stones were carefully selected so they could be dragged along the waters bottom surface without being caught or snagged. Thus allowing the nets to be retrieved and reused. Anchor stones, on the other hand, were chosen based on their shape to actually catch and hold a position.

Some stone tools use a handle, such as axe or scraper (refer to Figure 4). This represents a major step forward, even in the period of Stone Age tools, but just as valuable in the usage of basic technology today. This is the concept of using an item to extend one's reach or increase one's force. Thus, the beginning of the challenge, the ever-present cycle of how can make something better.

Figure 4. Axe, axe head, and scraper.

Searching for and assembling the materials required to make these tools required researching the past in order to recreate them in the same manner as ancient people. Then utilizing these basic tools to make the stone axe, scrapper, and other more complex tools clearly demonstrated just how technology progressed.

Classroom Experience

Students are accustomed to attending lectures and for the most part being a passive participant in the classroom. Being an active contributor in the learning process was a new experience for many of the students. Letting them see, touch, and handle actual items produced using these crude tools gave them a better appreciation for the ingenuity and creativity of ancient peoples. History and technology came alive for them.

As these crude tools were described and their use discussed the student's interest never wavered, its level remained high. Every eye was on either the tool being discussed or on the one in their hand. Questions and comments were continual with even the quietist students taking part.

The experiment was a resounding success. Active learning really worked. After each session the students were asking when the next one would be held. They simply couldn't wait. For weeks after each session the students talked about the tools before and after class. They even mentioned them to their friends increasing the interest in the class and raising the next Quarters enrollment.

Lessons Learned

After the first year utilizing active learning techniques to bring old technologies back to life numerous lessons have been learned. As a consequence, many of them have been directly incorporated into the demonstrations, hands-on experiences, and materials that will be used during the next academic year. The result has been an improved and more interactive classroom experience along with an enhanced level of student involvement.

Active learning created an environment of heightened interest in the subject even to the point where test and essay grades improved. This was a somewhat unanticipated consequence resulting from the project. However, it was one of the best possible outcomes from the experiment.

Doing something different in class to break the routine is welcomed and appreciated by the students. As a result additional activities and surprises are planned. Many will occur unannounced and without prior warning offering new opportunities to experience old and new technologies.

The only drawback from this active learning exercise was the extensive preparation time required to gather material and make the tools. However, it was an enjoyable experience recreating the past. A real plus was the cost involved, virtually none. Not many academic projects can actually make that claim. In the future costs will be incurred, but it is anticipated that they can be kept to a minimum.

Conclusions, Reflections, and the Future

It is a very challenging task to educate students with all of the vital knowledge that they will need in order to be competitive in a rapidly changing global environment. It requires understanding not only today's technologies but yesterday's as well. The overall objective is to adequately prepare engineering and engineering technology graduates for a future that is virtually unknown. In order to accomplish this goal an active learning approach was applied to a course exploring technologies from the past. Because it is through understanding of the past that the future becomes clear.

Looking back and reflecting on this project reveals substantial benefits both to the students and faculty. Foremost, the results indicate an increased student participation, awareness, interest, and retention of just how technology has evolved. In addition, engineering and engineering technology graduates now have a better understanding of past technological issues that can be used to address future challenging and competitive situations. Overall, the project was a resounding success worthy of all the time and effort expended to reach is objective.

In the near future this active learning approach will be expanded to include other areas of technology from the course until the entire set of topics is covered. Other courses are being examined to determine if a similar active learning style could be applied. Many of the engineering and engineering technology courses utilize a hands-on laboratory approach but the lectures are conducted in the traditional way. They may be good candidates for the active learning approach as well.

Bibliography

1. Allen, R. H. (2002). *Impact teaching: Ideas and strategies for teachers to maximize student learning*. Boston: Allyn & Bacon.
2. Bonwell, C. C., & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom*. (ASHE-ERIC Higher Education Report No. 1). Washington, DC: George Washington University.
3. Crabtree, D. E. (1972). *An introduction to flintworking.* Occasional Papers No. 28, Pocatello, ID: Idaho State University Museum.
4. Crawford, A. E., Saul, E. W., Mathews, S., & Makinster, J. (2005). *Teaching and learning strategies for the thinking classroom*. New York: International Debate Education Association (Open Society Institute).
5. Davis, B. (1993). *Tools for teaching*. San Francisco: Jossey-Bass.
6. DiSanza, J. R., & Legge, N. J. (2005). Business and professional communication: Plans, processes, and performance. Boston: Allyn & Bacon.
7. Loendorf, W. R. (2004). A Course Investigating Technology in World Civilization. *Proceedings of the American Society for Engineering Education (ASEE) Conference*, Salt Lake City, Utah, June 20-23, 2004.
8. Sousa, D. A. (1995). *How the brain learns: A classroom teacher's guide*. Reston, VA: National Association of Secondary School Principals.
9. Tileston, D. W. (2007). *Teaching strategies for active learning: Five essentials for your teaching plan*. Thousand Oaks, CA: Corwin Press.
10. Weimer, M. (1991). *Improving college teaching*. San Francisco: Jossey-Bass.
11. Whittaker, J. C. (1994). *Flintknapping: Making and understanding stone tools*. Austin, TX: University of Texas Press.