'OLD DEAD GUYS'
Using Activity Breaks to Teach History

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Teaching students in the classroom on a regular basis quickly reveals the importance of activity breaks. Activity breaks can be used for active learning exercises such as in-class teams, think-pair-share, or minute papers.[1] The core elements of all active-learning methods are student activity and engagement in the learning process. These methods have been shown to have a positive effect on student learning.[2]

An alternative focus of this active-learning activity break can be to educate students about the history and personalities of chemical engineering. Almost every lecture in a chemical engineering class contains references to the people and their accomplishments that form the foundation for today's students: Antoine equation, Gibbs' free energy, Arrhenius equation, Reynolds number, McCabe-Thiele plot, Bode plot. Why are these figures famous today? Because they came up with solutions to important problems. While many of these historical figures are at least vaguely familiar to us as instructors, the students are usually completely unfamiliar with them. By focusing on the history and personalities, chemical engineering comes alive and the students become familiar with the human side of our profession. These examples can also be used to demonstrate to students the reasons why these problems were so important and how their solutions led to practical developments and applications. Since there is often at least one historical figure mentioned in every class lecture, they provide an opportunity to re-engage the students and refocus on the topic through the use of a historically focused activity break.

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APPROACH

When a historical figure is encountered during a class period, it is often part of a derivation, and student attention is waning. This provides an ideal opportunity for a historically focused activity break. This break serves as a way to put an exclamation point on a concept and to connect the person to this concept. The students are first asked to guess when the historical figure lived and did the work that bears his or her name. As expected, a few wildly inaccurate guesses usually result. Next, the students are shown a picture/portrait of the historical figure. Slightly more accurate guesses are then given. The guesses serve as a way to encourage participation. Since no one is likely to know the answer, a wrong guess does not demonstrate a lack of technical knowledge to their peers. Finally, the students are shown a picture together with biographical information about the historical figure. This information typically includes birth and death dates, institutions attended, degrees earned and dates, major accomplishments,

TABLE 1
Biographies Used in Kinetics and Reaction Engineering Class

Svante Arrhenius	Edward Teller
Cato Guldberg	Paul Emmet
Peter Waage	Irving Langmuir
Maud Menten	Thomas Sherwood
Leonor Michaelis	Alan Colburn
Hans Lineweaver	Ernest Thiele
Dean Burk	Gerhard Damköhler

and awards earned (Figure 1 and Figure 2). The degree and institution data show students that people from many fields have contributed knowledge important to chemical engineering. It also exposes students to the importance of advanced degrees in science and engineering but also that some historical figures had no more than a bachelor's degree. Major accomplishments other than the one of current interest are also listed. In this way, the versatility of these historical figures is demonstrated as well as the fact that people often succeed and contribute to fields outside their area of study. The break is concluded with a short discussion of why the accomplishment occurred at that time, the historical context in which it occurred, what other historical events influenced it, and other broad societal influences (intended and unintended).

RESULTS AND DISCUSSION

The historically focused activity breaks have been used over the last five years in two separate courses (a junior-level required course in Kinetics and Reaction Engineering and a senior-level elective in Industrial Chemical Production). For the Kinetics and Reaction Engineering class, 14 biographies have been developed (Table 1). Six biographies have been developed for the Industrial Chemical Production class.

From the instructor perspective, what appears to draw the students into the presentations is when they include controversy. For example, Thomas Midgley was responsible for two of the most important inventions of the 20th century: tetra-ethyl lead gasoline additive and chlorofluorocarbon refrigerants. These inventions lead to the tremendous success of the automobile and allowed large population growth in the American south and southwest. As a result of these inventions he won numerous awards. Before the century was over, however, the side effects of these inventions were well known and both substances were tightly regulated. Similarly, Fritz Haber and Carl Bosch developed catalysts to produce ammonia from nitrogen and hydrogen. This allowed Germany to make explosives for its war efforts after it lost access to conventional nitrogen sources. On the positive side, subsequent ammonia production and use as a fertilizer has also allowed a worldwide expansion of agriculture production. Examples such as the two above help our students understand the impact

Image used by permission of Thomas Midgley IV.

Thomas Midgley, Jr.

b. 1889
d. 1944

Ph.D. Cornell

1922 Discovered tetraethyl lead as anti-knock additive to gasoline.

1928 Discovered chlorofluorocarbons were essentially "inert" and could be used as refrigerants.

Nichols Medal 1922
Perkins Medal 1937
Priestly Medal 1941 (ACS)
William Gibbs Medal 1942

Figure 1. *Thomas Midgley picture and biography for classroom use.*

Wilhelm Ostwald

b. 1853, Riga, Latvia
d. 1932, Leipzig, Germany

Univ. of Tartu 1875 (Estonia)
Univ. of Tartu 1878, Ph.D.

1877: Prof. of Physical Chemistry at Leipzig University. Students included:
Arrhenius (Nobel Prize 1903)
Van't Hoff (Nobel Prize 1901)
Nernst (Nobel Prize 1920)

Received Nobel Prize in Chemistry in 1909 for "Work on catalysis, chemical equilibria, and reaction velocities."

Figure 2. *Wilhelm Ostwald picture and biography for classroom use.*

of engineering in a global and societal context and contribute directly to desired outcome (h) of Criterion 3 in ABET.

Students can also be educated about the practice of science and engineering through these historical biographies. For example, most faculties are aware of the mentor/mentee relationships between professors and graduate students. If the historical biography lists an individual's advisor and students, the students can see how one generation of scientists educates/trains the next generation. An ideal example of this is Ostwald, who mentored three Nobel laureates (Figure 2).

Whenever possible, women and minorities should be featured as historical figures (*e.g.*, Maud Menten of Michaelis-Menten kinetics). There is an ongoing effort by the NSF and other organizations to encourage the participation of women and minorities in science and engineering. By highlighting the contributions of these groups, our own students can be encouraged. It should also be noted that many historical women and minorities succeeded in spite of the roadblocks placed by society. This can be used to show students that anyone can succeed despite whatever roadblocks they face. Resources focused on information specifically about women and minorities in science may be used to prepare these biographies.[3-5]

The use of historical biographies also allows the opportunity to expose undergraduate students to the scientific literature. Show the students a copy of the paper where Thiele investigated the relationship between catalytic activity and particle size[6] (which led to the Thiele modulus) or when Michaelis and Menten published their understanding of enzyme kinetics.[7] By showing students the original papers, they can begin to understand the process whereby a problem evolves into a research project, becomes published in a research journal, is accepted by the researchers in the field, and graduates to textbook fundamentals.

Information and images for these biographies can come from a wide variety of sources. For historical figures in transport phenomena, Bird has presented an extensive list of microbiographies.[8] Similarly, for historical figures in catalysis, more in-depth information is available from Davis.[9] Additional published sources include the *Dictionary of Scientific Biography*,[10] the *Bibliographical Memoirs by the National Academy of Sciences*,[11] and the *Memorial Tributes* series by the National Academy of Engineering.[12] Finally, the American Institute of Chemical Engineers is currently celebrating its centennial; as part of this celebration, a number of sessions at the fall 2008 meeting were devoted to the history of chemical engineering. Thus, the meeting proceedings may provide another resource.

Many online information sources are quite useful. The International Center for Heat and Mass Transfer has a Web page with biographies of historical figures with dimensionless parameters named after them.[13] If the figures come from a medicine/biology background, the <whomanedit.com> Web site provides biographical information.[14] Finally, Wikipedia provides an ever expanding source of information.[15] For images, useful Web sites include the ChemTeam Photo Gallery[16] and Pictures of Physicists.[17] Again, if all else fails, both Google and Google-image searches can cast a very wide net.

STUDENT FEEDBACK

Student response has been very positive and in fact they are responsible for coining the term "Old Dead Guys." After a few of these biographies were presented, the students started to expect them, often asking before class if there will be any "Old Dead Guys" today. Additionally, the students have pointed out instances where I have missed opportunities to present more of these biographies. In several cases where it was difficult to locate an image of the historical figure, individual students have instigated their own successful Web searches to find an image. All of these responses indicate that the students are taking ownership of the concept.

The most recent class went a step further. They spontaneously decided to determine which member of our department most resembled the historical figure. Due to the preponderance of beards on 19th-century scientists, the two members of our department with beards were frequent winners. Subsequently, this class incorporated this idea into their own classroom presentation. Approximately 75 percent of the student presentations included a biography of a historically relevant figure. Several students also noted to me how hard they worked to find biographical data and images of the historical figure. Additionally, as part of these presentations, the students competed informally to see who could incorporate the oldest historical figure into their presentation.

CONCLUSIONS

Historically focused activity breaks provide an excellent way to incorporate history into the classroom. By connecting the historical figure with a solution to an important problem, the students gain a better understanding of the subject matter. These history lessons also serve to put a human face on chemical engineering while providing an opportunity to educate students about the broader societal impact of science and engineering.

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