
The Trial of Lavoisier: A Strategy for Teaching Chemical Revolution in a History of Chemistry Course

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To engage students in the study of history is a challenge for all who teach history of chemistry. Traditional methods for teaching at the higher education level usually employ a lecture format of instruction in which the majority of students listen passively to the instructor and jot down notes. The Sao Paulo History of Chemistry course was, in most ways, identical with courses taught in other Colleges and Universities across the world. Lectures and discussion sections, with a textbook, a few paperbacks, and occasional library readings constituted the bulk of the course. The lecture topics moved chronologically from one period to another, from one aspect of society to the next, while students covered one bloc of readings after the other in quiz sessions, with little correlation between lectures and discussion sections.

Current views of learning and instruction challenge the wisdom of this traditional pedagogic practice by stressing the need for the learner to play an active role in constructing knowledge¹. In this age of active learning, teachers are looking for alternatives to the traditional lecture format and, as a result, they are discovering that debate offers a powerful tool for enlivening their teaching and energising their students. When students engage in debate, they take an active role in their education, and subjects which once may have seemed dull and abstract come vividly to life. These exercises not only draw students into the lesson in a more active way, they also provide students a critical skill that they do not necessarily learn from listening to a lecture. In preparing to debate a controversial question, students undertake a wide range of learning processes. They have to ask themselves what these questions mean personally to them; they have to research the social, political, ethical and historical contexts in which the issues are situated; and they can learn to see complex problems from widely different perspectives. Because this learning is geared toward a specific purpose, that of performing well in the debate itself, students have added incentive and a clear goal to work toward. The objectives are frequently directed toward both social and cognitive

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goals. The social goals include active listening, taking turns, consideration of others' view, and arguing without becoming angry. The cognitive goals include weighing and evaluating arguments.

It has been found that a mock trial is a useful tool not only for engaging students in active learning during the class hour, but also for enhancing the overall communication within the classroom. In a mock trial, students put a character on trial and then simulate the process with students playing the roles of the accused, the witnesses, court personnel and media. The multiple roles required in the trial make room for various student skill levels and public speaking abilities. While offering a variety of ways for students to participate in and learn from the activity, the mock trial format also ensures that all students grapple with and respond to historical evidence. The use of mock trials is not new concept in teaching, especially for pre-law or paralegal programs and there is an extensive body of research for using trials at all levels of education. College courses in English, sociology, communications, business, and even mathematics have all utilised mock trials. Mock trials have also been used in social studies classes to address historical issues, current events, or as a way to integrate social studies with language arts². However, comparatively little has been done using mock trials in higher education courses. This account describes an idea for an interesting teaching strategy for history of chemistry classrooms and how this strategy was implemented.

Procedure and Discussion

During a recent semester, an activity class was structured around a fictitious trial of Lavoisier. Earlier, the Chemical Revolution one unit had been found especially effective because, as an event in space and time, it was easily identified, but what was not so easy to determine was the meaning, or the significance, of this event, both for its participants and for subsequent commentators. It occurred towards the end of the eighteenth century and involved European science in an upheaval of considerable scope and consequences³. The issues that arose during the chemical revolution centered around experiment and theories concerned primarily with the chemistry of gases ("airs") and the phenomena surrounding burning and other forms of what is now called oxidation. During the 1770s the discovery of "airs" led to the rapid growth of intensive work on combustion, and to widespread interest in it within fashionable circles in Paris and London⁴. Thorough examination of the weight relations led Antoine Lavoisier to question the phlogiston explanation of combustion⁵. During the 1780s, Lavoisier developed a counter theory and undertook supporting experiments to a point where he was able to convert the leading

chemists of France (including most of his colleagues in the Paris Academy of Sciences, one of the world's leading scientific institutions at the time) to it. By the end of the 1790's, most British and European chemists had also been converted as well⁶. Besides this, Lavoisier was perhaps the most controversial historical figures related to the Chemical Revolution and his participation on this event is still shrouded in mystery and alive with controversy. So, the central question of the trial, was Lavoisier the responsible for the Chemical Revolution? was broad enough so that the students had to several issues to consider.

The class was composed of forty first-year students. Three class periods of one hour and forty-minute each (not including out-of-class student preparation time) were organised. In the first one, after the rules were explained, the roles to be played during the trial were assigned and the instructions given for the pre-trial student activities. The class had, therefore, knowledge about the purpose of the activity, an overview of the activity including how their work was to proceed, and a clear understanding of the time frame and of the required end product. To prepare the students for the trial, some reference sources were recommended to provide enough background to use effectively the trial as a learning experience.⁷⁻¹⁰ The use of the original documents and sources for the historical research was encouraged and the students also could to do Web researches or to consult other references for background information. Furthermore, watching films about the period they were researching was encouraged, with the caveat, movies do not replace historical research.

The class was divided into three groups, and a role was assigned to each group. The roles were rather loosely defined by positions in the debate which was to follow; i.e., prosecutor, defender, or judge. A student volunteered to play the role of Lavoisier, one group was to act as the prosecutor, one as his defense, and the other as his judge, and one student played the lead counsel (advocate) for each side. The remaining students had to assume the roles of witnesses representing historical figures such as Marie-Anne Lavoisier, Fourcroy, Priestley, Cavendish and Black. They also had to prepare briefs for their lead counsel to question witnesses from the other side. The roles were structured so as to maximise the level of disagreement in the ensuing discussion and to represent a variety of perspectives on the historical situation. Dividing the roles this way immediately established an adversarial relationship among the groups.

Arguing about whether Lavoisier was the responsible for the chemical revolution did not seem very productive until the court-room scenario imposed goals for each group, for the prosecution and the defense, victory of their argument, for the judges, a fair verdict. Group work is problematic, perhaps even more so in a class-

room where most of the students work a minimum of thirty hours per week. These conditions make it difficult for group members to meet outside the class. Group contact was encouraged. Thus, on the second class, each group met and prepared its positions. At the end of this class, all students submitted to the Professor a written statement (300–500 words) in which they articulated the Lavoisier role on Chemical Revolution. Before the trial, these written accounts were reviewed and suggestions made for their improvement.

On the trial day, ten minutes were allocated for each side's opening statement and presentation of their case. The prosecuting and the defense attorneys had twenty minutes to produce their two to three witnesses and to cross examine as many witnesses as they liked. At the end, each side had ten minutes of closing arguments. Track of time was kept using a half-hour glass and each side given some general indication of how much time they had left, e.g. "Half your time has elapsed," "You have one quarter of your time left," etc. Each side could call a break at anytime, to collect their thoughts, stretch, and/or get refreshments. Once the prosecution began their case, the trial moved with surprising ease. The defenses' case was well conceived, planned, and articulated. There were no unexpected snags, few objections, and, apart from some sharp verbal altercations between the two lead counsels, no major problems. The prosecutions were clearly unprepared for the thoroughness and clarity of the defenses' case in part because no one knew what to expect and in part because of student procrastination. The instructor did not participate in the deliberations, but listened to the tribunal's comments, offered historical clarifications when asked, and solicited opinions about student performances. The deliberations were enlightening. After much discussion, but without exception, the tribunal concluded that the defense was the most convincing team. When the judge returned to read the verdict, the excitement and tension in the air was evident. Never had the instructor been in such an emotionally charged room as part of an academic exercise.

Finally, it was necessary to consider how to assess grades. All written work should be done individually. The students playing witnesses wrote two to three-page "briefs" about their respective explanation, while the lead counsels wrote a four-page essay detailing their strategy and how they planned to cope with the strengths and weaknesses of their respective issues. The student who played Lavoisier wrote a five-page essay on Lavoisier's background and his ideas regarding many of the prominent issues likely to be discussed. Students also were graded on participation in class, their preparedness to discuss readings, their performance as witnesses, the depth of understanding of the witness, ability to answer questions as witnesses (to the best of their ability), and demonstration of appreci-

ation for the issues at hand. In addition group members were rated from 1-5, in categories, including (though not limited to) responsibility, cooperation, research, and overall performance. However, only one grade in this assignment is a “group grade”, the presentation. Therefore, meeting as a group is not as burdensome as it can be with other types of group projects.

Conclusions

Overwhelmingly students enjoyed this project but when they complained it was usually about the research and the groups. Their complaints usually mentioned conflicting schedules, their aversion to group work, and the amount of research required. Most students, however, liked the groups and the research. One student noted that the researching with a group was “very helpful and less time-consuming” and it provided him with “a chance to meet some of my classmates”. Others commented that listening to their classmates opened their eyes to different interpretations. Not all of the students were equally successful, but some were transcendent and memorable. The quality of student work produced as part of the mock trial was consistently of high quality. Most students were able to construct interesting historical arguments based on evidence they have read, heard, and acted out. Perhaps it was this mix of learning styles that contributed to the students’ enjoyment of the experience. The mock trial has generated enthusiasm among students that standard class discussions did not, and the fact that the outcome of the trial depends on student argumentation has created a higher level of student commitment to the curriculum. Equally important, students were very positive about mock trial instruction and believed that they learned more during class exercise than they would have during a traditional lecture.

However, all pedagogical strategy can and should be revised and improved each time they are used. The ambiance could be further enhanced in the future by the use of music, flags, and period art. In this account are given the issues confronted during a fictitious trial of Lavoisier. This kind of pedagogical device allows introducing historiographical debate and promotes meaningful critical analysis of historical sources and issues. Mock trials enhance active learning, foster a cooperative spirit, inspire hard work, and allow students to share their knowledge in a unique setting. The weaknesses can be remedied and the strengths further developed to create a memorable and effective course. The trial format requires a great deal of planning, flexibility, patience, and perseverance, but the rewards are well worth it, for student and Professor. They require a fair amount of work, both for students and for teachers, but if they are structured well, they can be a high-

light not only of one course, but of a student's entire learning experience, and the lessons learned can easily last a lifetime.

Despite any weaknesses, the trial was a success for student and professor alike. Most students agreed that this type of activity is valuable both for them and for future students. They appreciated the novel pedagogical approach to the subject. The value of such a trial is that it allows students to work out for themselves complex historical debates and situations. Sometimes they come up with unusual perspectives on the debates, ones that could not have been predicted. These discoveries are the most rewarding part of the learning and the teaching experience. Such an applied approach not only helps students to acquire and retain substantive material, but also increases their motivation and enjoyment in the class as well as generates higher-order thinking. This activity involved preparation time, outside readings, and written requirements. In conclusion, the mock trial is a stimulating alternative way to teach history of chemistry.

The trial became the starting point for students' historical research, but it also opened students to the new ideas about history of chemistry and theatre. Many students were intrigued by the use of plays and expressed interest in seeing them performed. Someone opened their minds to theatrical productions as more than a source of entertainment. Then, guidelines for student-developed productions were prepared¹¹⁻¹⁴. The students suggested a theatre script entitled, "The judge of Lavoisier", with a brief description of each scene, a historical time line of the topic, a list of important historical persons involved, and a bibliography of resources. Finally, they performed a dramatisation for an outside audience in December, 2007. This participatory drama brought enormous fulfillment to these students. For some it was the first time that they had ever read a play, and most expressed their enjoyment at using plays in this "unconventional" way. The effort they put into script writing, rehearsals, and performances required ongoing discussion and analysis of their information until they reached an understanding of the underlying impact of the event on its participants. It is believed that the form of the historical drama is an exciting means to educate and entertain at the same time. Seeing a drama take place before you and knowing that these conflicts really did happen is far more stimulating than a fiction which is entirely made up.

All these activities, in which personal metadidactical strategies were developed, have given the opportunity to act as being more than a dispenser of information to a classroom of passive students. It is concluded that the traditional teacher-centered model in which knowledge is "transmitted" from the trainer to the trainee can be usefully replaced in part by alternative models of student development (constructivist and sociocultural ones).

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