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RESEARCH REPORT

Chemistry Is in the News: Taxonomy of authentic news media-based learning activities[1]

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A brief history is given of approaches that aim at achieving a connectedness of the content of organic chemistry courses to real world issues. Recently, such approaches have relied more and more on online media resources, the tools of the Internet and the World Wide Web. We propose a six-level taxonomy of 'authentic news media-based learning activities' to provide a conceptual framework for the description and discussion of such approaches. The *Chemistry Is in the News* project was designed to allow students to draw explicit connections between the course content and real world issues in ways that engage the students in a full range of cognitive skills. The activities consisted in the study, creation, and peer review of news portfolios by student collaborative groups. A news portfolio consists of an authentic news article taken from the popular press with interpretive comments and questions.

Introduction

Educators, researchers and administrators have strongly emphasized the importance of students constructing the connection between the content of chemistry courses and real world issues and problems (American Association for the Advancement of Science, 1990; National Committee on Science Education Standards and Assessment, 1995; National Science Foundation, 1996). Constructing the connections is important for purely pedagogical reasons, such as information retention (Bodner et al., 2001; Taylor et al., 2002). The construction of connections also has importance with a view to sociological and political consequences; for example, creating life-long learners and educated citizens (Glaser, 2003; Singh, 1995; Zoller et al., 1999). The higher goal of chemistry education is thus well defined, the significance and importance of achieving this goal has been well justified and it is widely accepted. The grand challenge at this time concerns the design, the

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implementation and the assessment of teaching methods that accomplish this ambitious goal in a systematic fashion. These methods should be fit for widespread adoption so as to serve as teaching tools that can lead to systematic change.

In order to affect this change, we first offer a review of traditional and emerging strategies for the integration of real world content into organic chemistry courses. Many of these strategies utilize newspaper articles to define the real world issues, and, more recently, online news media play an increasingly significant role. Next, we propose a taxonomy of 'authentic news media-based learning activities' to provide a conceptual framework for the discussion of the various approaches and the evaluation of their educational benefits. The *Chemistry Is in the News* activities consist of the study, creation, and peer review of news portfolios by student collaborative groups. A news portfolio consists of an actual news article with interpretive comments and questions.

Brief history of authentic news media-based learning activities

There are currently three main approaches employed in the teaching of organic chemistry. Most modern textbooks of organic chemistry use a combination of the 'functional group' and 'mechanistic approach', which involve the study of groups of atoms, how they form, and the processes through which these groups react with each other. Another method utilized is the 'synthesis approach', where the focus is on understanding the chemistry through retro-analysis. A third technique is the 'connectedness to real world issues approach', which uses tangible examples of chemistry to demonstrate important concepts. Each of these approaches has its strengths but each also fails to be an effective tool at every level. Thus, one is presented with a choice in fulfilling the goal of helping students make real world connections to their chemical education. The first option is to make 'connectedness to real world issues' the key organizational guide; this philosophy is found in the 'Chemistry in context' project (Stanitski et al., 2003; Stratton et al., 2000) and a few textbooks (Hill & Kolb, 2001; Sherman & Sherman, 1992) for non-science majors. This would help students grasp the fundamentals to the extent they affect their lives. The alternative consists of the development of effective strategies to embed the goal of 'connectedness to real world issues' within the framework of the 'functional group/mechanistic' approach, which attempts to add a 'real world' dimension to conceptual study.

'Chemistry in context' and 'boxed essays' approaches

'Chemistry in context' is a project of the American Chemical Society that has led to the publication of an innovative textbook for non-science majors that aims at establishing chemical principles within a contextual framework of significant societal–technological issues (Stanitski et al., 2003; Stratton et al., 2000). This method characterized the first option, 'connectedness to real world issues approach', as each chapter addresses an important societal issue (energy, food, drugs, etc.) and the material is presented to the students in a way that stresses the direct effects of chemistry on

their lives. The approach develops chemical knowledge on a need-to-know basis so that students can more fully appreciate its contextual relationship to the topics.

The presentation of chemistry in the context of significant societal–technological issues fulfills the goal of teaching real world connections to non-science and science majors alike. However, the education of science majors, and especially of majors in chemistry-related fields, requires a more systematic study of chemical principles. This is particularly true for chemistry since the majority of chemistry and chemistry-related majors will be employed in research settings. Given these priorities, it appears reasonable that the choice between the 'Chemistry in Context' approach and the 'functional group/mechanistic approach' is decided in favor of the latter for chemistry majors, and possibly for all science majors.

A happy medium between the two approaches, as suggested earlier, has been attempted; in most textbooks following the 'functional group/mechanistic' approach, a number of teaching strategies have been used to help students make the connection between the abstract chemical principles and the real world. Strategies such as these enhance the interest level of the course content and they help students see connections. For example, the 'boxed materials' in Bruice's (2001) *Organic chemistry* bring life to the topics discussed. The books by Wade (2003) and by Vollhard and Schore (1999) both feature many photos of everyday experience. Carey (2003) also employs 'boxed essays', some of which focus on societal implications. McMurry (1999) provides 'interludes' to enliven and reinforce the materials presented. Solomons and Fryhle (2003) similarly integrate 'The of …' essays into the text to highlight special topics, and chapters begin with a vignette that shows how the chapter's subject matter is related to the 'real-world'. The text by Brown and Foote (2001) provides 'Chemistry in action boxes' to illustrate everyday applications of organic chemistry. The text written by Hornback (1998) is the most extreme approach to date toward teaching organic chemistry by way of case studies. The 'elaborations' in this text indicate a pronounced move away from the traditional approach while increasingly embracing the principles of the 'in context' approach.

Newspapers are the mirrors of society

The topics of the 'boxed essays' all have made headlines in the past, and many of the topics continue to be of genuine interest to society. It is therefore only natural that one goes one step further and employs topics of societal relevance that are currently in the headlines. There are many sources available to those who wish to engage in this strategy. A prominent example is 'Themes of the times', a mini-newspaper the *New York Times* has been producing for several years. It features selected articles of the *New York Times* science pages, is updated annually and is available free-of-charge to adopters of Prentice Hall textbooks. A second source is Simon and Schuster's *College NewsLink*, a unique educational online news service. Instructors and students can access articles from leading newspapers from around the world. The articles are organized by academic disciplines and are chosen for their educational relevance. *Sigma Xi*, the Scientific Research Society, provides a third

resource with free daily email update on science news from US newspapers (Sigma Xi, Scientific Research Community 2002a). Although the *MediaResource* service's primary purpose is 'to put journalists in touch with reputable sources of scientific information', this 'Science in the news' service also presents a useful teaching tool (Sigma Xi, Scientific Research Community, 2002b). In addition, the college edition of *InfoTrac* is an online service that provides Internet access to complete articles from over 600 publications (Thomson Corporation, 2003). This service is available free of charge with the adoption of Wadsworth or Brooks/Cole textbooks, which include the texts by Hornback (1998), McMurry (1999) and Fessenden and Fessenden (1998). *InfoTrac* allows for access to current news media, popular science publications and also to more specialized journals. Finally, university libraries frequently have site licenses for the web edition of many scientific journals and it is reasonable to expect that this access will become more widely available in the future.

Taxonomy of authentic news media-based learning activities

Newspapers are the mirrors of society and newspaper articles allow one to construct the important relations between society and chemistry

Although the natural extension of 'boxed essay' approaches is to employ current articles from newspapers and online news media, there is one significant difficulty with this approach. This difficulty is that, without some guidance, students initially may be unable to draw connections between the abstract chemical principles they are learning and the real world topics discussed in the articles. Drawing connections between chemistry and the real world serves as an end of chemical education and as a means to facilitate learning, and therefore requires attention. Ideally, one wants to engage the students in a full range of cognitive skills that range from the acquisition of knowledge and the development of comprehension to application, analysis, synthesis and evaluation (Biehler & Snowman, 1986; Bloom et al., 1956). Hence, there exists a clear need to develop strategies to integrate the media resources into science courses in a way that enhances the interest in the course and content and helps students to see the connections.

In this context, we suggest a taxonomy of 'authentic news media-based learning activities' (Table 1) to provide a conceptual framework for the description and discussion of such approaches. The activities, in principle, can be carried out by individual students or by collaborative student groups. We favor the group approach because it provides many educational benefits (Glaser & Poole, 1999; Miller et al., 2001).

The theoretical basis for this taxonomy stems from the science philosopher Jacob Bronowski's (1965) representation of science, which consists of the public and the private spheres. This concept is not an isolated theory, but has been expanded on by other philosophers, notably by Jürgen Habermas (1991). Like Bronowski's depiction of science, the taxonomy consists of two main categories, content and assessment of creation, which each have three subdivisions of increasing complexity. The content category's focus, in levels one through three, is on the students' internal knowledge

Table 1. Taxonomy of 'authentic news media-based learning activities'

Level	Activity	Quality review	Resource	Focus
1	Read News Article	None	Online News Media	Issue Awareness & Interest
2	Read News Portfolios	None	*Chemistry Is in the News* Online Database	Knowledge & Comprehension
3	Read & Create News portfolios	Instructor Review		Application, Analysis & Synthesis
4	Read, Create & Judge News Portfolios	Intra-Class Peer Review	*Chemistry Is in the News* IITN Software tools	Evaluation Constructive Review
5	Read, Create & Judge News Portfolios	Inter-Class Peer Review		Awareness of diversity
6	Read, Create & Judge News Portfolios	International Peer Review		Awareness of International Context

development. This corresponds to Bronowski's private sphere of science, in which the individual explores and creates his/her own scientific understanding. The second category is assessment of creation. This is where students mimic the scientific process by peer-reviewing their creations built out of their scientific understanding. This is the public sphere about which Bronowski wrote, where the debate, dissent and free exchange of ideas, which are necessary for the development of science, take place. The synthesis of these private and public spheres defines 'science' and understanding this complex interplay is understanding the difference between science literacy and scientific literacy.

The content levels: increasing engagement and science literacy

Level 1 activities: reading the news

The first opportunity for individual intellectual development is involving students in reading printed or online articles. The news articles are provided with minimal guidance and without any well-defined approach to connect the content of the news articles to course content. All of the media services already discussed qualify as level 1 activities. To really meet pedagogical needs and to provide true scientific literacy, students must do something with the connections. The students need a conceptual understanding of the science content and they also need practice in evaluation of evidence. These goals are addressed in the higher levels of the 'authentic news media-based learning activities'.

Level 2 activities: working with news portfolios

Level 2 addresses two fundamental needs; namely, the need for a well-defined approach to connect the content of the news article to the course content and the need

that students *do* something with the connections. At this level, an article is presented as an integral part of a 'news portfolio'. A news portfolio consists of an actual and recent online news article, interpretive comments and a number of questions. The interpretive comments serve to clarify the issues and facts, to objectively delineate the connections between the news and chemistry, and to provide additional information and background material. The interpretive comments include links to high-quality sites and they frequently include animations, graphics and movies. The addition of questions to a news portfolio makes the learning process a more active one. Well-selected questions can provoke critical thinking about the presented material and its societal, economic and environmental consequences, and answering the questions also requires a more in-depth analysis and evaluation of the material. Level 2 news portfolios are created by the instructor, thereby assuring both high quality of the educational material as well as its most appropriate placement in the course. The intellectual goals of level 2 activities focus primarily on knowledge and comprehension.

Level 3 activities: creating news portfolios

At level 3, the students become the *creators* of news portfolios. It is one thing to bring to the attention of the students the cogent chemistry issues of our times. It is even better if the students find out about these issues and collaborate to *create* news portfolios. The first of three major novelties at level 3 consists in the identification and selection of news media resources and the acquisition of skills to search for articles in these media resources. This focus on the sources of information and on the access to that source is a truly eye-opening experience for the students! Some guidance needs to be provided as to how to select among the vast numbers of available news media from around the world and as to how to select articles as candidates for the news portfolios. The second novelty at this level is even more important: at level 3, the students *make*—not just *recognize*—connections between course material and real world issues. It is more than likely that the final selection of an article for a news portfolio is made after a number of candidates have been considered. Hence, level 3 activities lead to the making of multiple connections and they require evaluation and judgment in the selection of the best source of material for the news portfolio that is to be created. This improves the retention of the material and it prepares students to be life-long learners. The third novelty at this level is the creative act of writing a news portfolio for one's peers. Writing a news portfolio requires more comprehension and understanding than reading an existing news portfolio. The application of knowledge, analysis of original sources, and the synthesis of a cohesive news portfolio are the intellectual goals at level 3.

Structure of the Chemistry Is in the News *news portfolios*

For each chapter, the instructor selected one actual newspaper article with a topic relevant to society and related to the chemistry discussed. Graphical user interfaces were written that provide hot-linked access to the news portfolios together with

Figure. The X-ray structure of HIV-1 protease with inhibitor Sdz283-910.

Protease Inhibitors and HIV

In 1997, the *Medical Tribune News Service* reported in an article entitled 'Future Of Aids Therapy Seen In Combining Protease Inhibitors' (Glaser, 2002) that 'a combination of two protease inhibitor drugs can suppress levels of the HIV virus to undetectable amounts'. This news portfolio illustrates well several of the guiding principles of the news portfolio design. First, the interpretive comments provide clarification of the types of drugs for AIDS treatment and it does so with reference to high-quality, credible and time-stable links. Johns Hopkins University is one of the national centers of AIDS/HIV research and the embedded link to the 'JOHNS HOPKINS *AIDS Service*' puts up-to-date knowledge at the students' disposal. It is the second major purpose of the interpretive comments to address the mechanism of action of protease inhibitors. Animations are employed for this purpose and the 'HIV infection' link in the 'Cells Alive!' site provides for excellent explanations of the role of HIV protease in the disease process and of the concept of HIV protease inhibition. The 'scissors analogy' leaves a lasting impression in the students' minds. With the concept of HIV protease inhibition clarified, the students are prepared to learn about an actual protease and its inhibition. Question 1 contains a link to the visualization materials of this chapter that shows the X-ray structure of one HIV-I protease with inhibitor. This structure was reported in 1998 and it was first employed in the author's teaching in early 1999. The connection between research and education is direct and immediate!

keywords characterizing the societal issues and the chemical topics that are being addressed. The headlines of news articles, the source and date of publication, the societal issue raised and the relevant chemical topic addressed can be viewed on the web (Glaser, 2002) for the texts by Bruice (2001) and by Wade (2003), and this

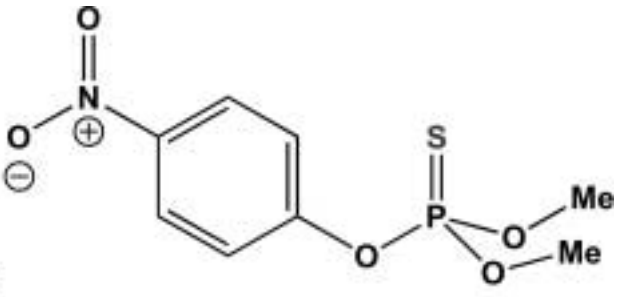
information is also provided in two tables in the supplementary material. The topics cover a wide range of issues and this breadth truly reflects the pervasiveness of organic chemistry in all aspects of life. While the books by Bruice and Wade differ significantly in organization and emphasis, the key issues occur in both texts and most news portfolios can be employed with minor adaptation for both texts. In fact, we also have been using these same *Chemistry Is in the News* portfolios in conjunction with the text by Carey (2003), and the future editions of the news portfolios will be written independent of any specific text.

The news portfolios created by the instructor and by the students have the same format. The articles vary from 200 to 2500 words and most articles are within a few hundred words of the average of about 900 words (about three double-space pages). The lengths of the interpretive comments greatly depend on the complexity of the issues addressed; some are just a few sentences and they can be as long as two double-spaced pages. The texts of the interpretive comments contain links to relevant online resources, and these links are selected using quality, credibility and stability criteria. Overall, we aim at limiting the comments to about 300 words (about one double-spaced page). Thus, the average length of an article and the associated interpretive comments are about four double-spaced pages. Brevity is a virtue, and the goal of the *Chemistry Is in the News* portfolios is not broad coverage but in-depth analysis and evaluation instead. The analysis is guided by the questions; each portfolio contains five questions that are chosen so as to represent of a variety of question types. The last question of each news portfolio is one that provokes reasoning about philosophical, societal and political implications to create discussion and debate.

The assessment levels: increasing debate and scientific literacy

Level 4 activities: peer review of student-created news portfolios

At level 4 the students' projects are evaluated by peer review rather than by instructor review. Peer assessment has long been used in writing courses and is now emerging as a means of assessing student work in a variety of fields (Bonwell & Eison, 1991; Freeman, 1995; Rafiq & Fullerton, 1996; Russell et al., 1998). Research has shown that peer evaluation supports collaborative group work in general and, in writing assignments in particular, it supports a shift in students' perspective from writing for the teacher to writing for their peers and, ultimately, for a larger audience. Since these project reports are published online and are ostensibly widely available, it is appropriate that peers review them. In addition, peer review is another form of communication (Berka & Berka, 1996; Kelter et al., 1996) and trains students in an essential aspect of the scientific process. Henderleiter and Pringle (1999) recently stressed that students must learn skills that go beyond the mechanics of chemistry, stating that '[a] chemist must be able to communicate with other chemists and non-chemists, work as a member of a team, evaluate data, and make decisions and recommendations based on data collected'. At this level, the students realize that reasonable people might look at the same data (e.g. food safety,



Methyl Parathion

Pesticides

Nucleophilic substitution is one of the central topics of organic chemistry instruction. To connect this chapter to a real world issue, we selected the article 'Ban Is Sought On 5 Pesticides To Protect Kids'. This article was published in *The Arizona Republic* on 29 January 1998. The article is about the adverse health effects of organophosphate pesticides, and reported 'The chemicals environmentalists propose banning are methyl parathion, dimethoate, chlorpyrifos, pirimiphos methyl and azinphos methyl'. There are several obstacles to making the connection between this article and the chemical principles and concepts students learn in the course. In the article commercial names are used for the pesticides. To think about the chemistry of the pesticides, the students first need to know the structures of the compounds. A good part of the interpretive comments are dedicated to this issue, and *ChemFinder* (CambridgeSoft Corporation, 2003) is employed to finding the structure. With the structure of methyl parathion known, the students are presented with the difficulty of applying nucleophilic substitution chemistry to the pesticide. Many students have great difficulty in applying the mechanism of nucleophilic substitution to a molecule as complex as methyl parathion. It is difficult to recognize the 'leaving group' of the substrate when the leaving group comprises most of the molecule. The situation is further complicated by the fact that methyl parathion contains more than one center that can undergo nucleophilic substitution. Still another difficulty concerns the fact that nucleophilic substitution of methyl derivatives usually are taught as 'a substitution of the leaving group X by the nucleophile Y' and it is non-trivial for the students to change perspective and to recognize this process as 'a transfer of a methyl group from X to Y' or as 'a methylation of Y'. The first two questions guide the students to learn about the structures of the pesticides structures and their S_N chemistry. The last question is meant to stipulate discussion of philosophical, ethical and judicial issues concerning the use of pesticides.

This news portfolio is based on an article published in January 1998 and it was employed as a teaching material within a year of publication. Aside from addressing a *current* issue, such activities also prepare the students to better appreciate any related *future* news. The pesticide news portfolio stresses the potential long-term benefits in an excellent fashion. On 2 August 1999, the Columbia Tribune reported under the headline 'EPA to ban fruit pesticide' that the Environmental Protection Agency banned methyl parathion from use on all fruit and many vegetables (see http://archive.showmenews.com/archive/1999/aug/19990802news10.htm). On 8 June 2000, the EPA banned the use of chlorpyrifos in gardens and homes (see http://www.arizonarepublic.com/news/articles/0608PESTICIDEBAN.html). On 5 December 2000, it was reported that the EPA requires the phasing out of diazinon (see http://www.discoveryhealth.com/DH/ihtIH/WSDSC000/333/341/305096.html).

drug approval, etc.) and, for legitimate reasons, arrive at different conclusions. Students also learn that the rigor of scientific analysis is diminished when applied to complex real world situations. Absolute judgment disappears, students learn how to deal with imperfect options, and they start to appreciate the difference between the ideas on which the *Substantial Equivalence Principle* (WHO, 1995) and the *Precautionary Principle* (Ecologic Inc., 2002; Environment Canada, 2003) are based.

Level 5 activities: inter-class peer review of news portfolios

Level 5 presents the step from intra-class to inter-class peer review. Inter-class peer review requires a situation where the same creative learning activities are being pursued concurrently in two similar courses at different universities and the students of the two courses review each other's projects via the Internet. Relatively little has been done in terms of using the Internet for such student interactions across institutions, although some authors have discussed the potential use of cooperation via the Internet to solve chemistry problems and provide feedback online (Towns et al., 1998). Aside from the additional management effort, level 4 and level 5 activities differ significantly. Pedagogically important are the facts that the evaluators no longer know the evaluees, that they have been instructed in different places in slightly different ways and, most of all, that their backgrounds and experiences may be greatly different. Indeed, the students would benefit the most if some of the views held by the different groups were in conflict. Imagine news portfolios on 'nicotine and smoking' created and evaluated at universities in Minnesota and South Carolina, or news portfolios on 'acid rain' created and evaluated at universities in Michigan and upstate New York. External peer review contributes to the development of the students' ability to present their own positions and hear, understand and respect other points of view. Hence, level 5 activities develop appreciation of diversity and present a step toward becoming a 'good citizen'.

Level 6 activities: international peer review of news portfolios

Level 6 presents the step from domestic inter-class peer review to international inter-class peer review. The courses whose students review each other are taught in different countries. Border-crossing peer review presents a powerful strategy to stimulate the students' global awareness and provides a mechanism to add a global dimension to 'authentic news media-based learning activities'. This is important in an atmosphere of increasing globalization, especially in light of the fact that less than 10% of students study abroad. There is need for an 'internationalization at home' aspect to be added to all curricula in order to prepare the remaining 90% of students for life after the university (Nilsson, 1999).

In level 6, like level 4 and level 5, the peer review results affect the students' score, and thus they need to be aware of the international perspective while they work on their projects in order to be successful. The next stage would involve the integration of topics of specific bilateral relevance, and the ultimate challenge would be presented

by the international collaboration in the preparation of the group projects. Level 6 activities thus present an opportunity to help students to become 'good global citizens'.

Implementation and Application of the Taxonomy

The utility of the taxonomy first became evident during the implementation of the *Chemistry Is in the News* activities by the authors. The taxonomy also provides the basis for faculty development, dissemination and the logical structure for the creation and the use of the web tool, which was created to make this curriculum more manageable.

Chemistry Is in the News has been successfully implemented at various stages since 1999 (Table 2). Thus far, the focus has been on the organization and management of the *Chemistry Is in the News* curriculum. The first challenge was the publication of the materials and students' work online. Initially, the instructor was responsible for the hypertext coding and, as a result of the time this demanded, levels 3 and 4 were only implemented once per year. Once a web tool was created (Wu & Glaser, 2001, 2004) and first used in winter semester 2002, the publishing of students' projects no longer required the faculty member's time, leaving only the maintenance and monitoring of the publishing and peer review process. The clear delineation of the levels in the taxonomy was a prerequisite for the programming of the web tool because the web tool is used to implement the various levels of the *Chemistry Is in the News* program. In particular, the distinction of the levels in the web tool facilitates the assessment process by allowing different parties to review the projects depending on whether the projects are to be instructor, in-class, externally or internationally peer reviewed.

The second challenge has centered on convincing others of the curriculum's validity. Students are a perennial group that must be convinced as this is a new form of instruction. Resistance is very common, and its focus tends to be on extra and unnecessary work they perceive being asked of them. Despite the initial opposition, after the course has ended, students report that it was a valuable part of the learning

Table 2. Implementation of *Chemistry Is in the News* at the University of Missouri

Semester	Course	Levels
Winter semester 1999	Organic Chemistry I	1, 2, 3, and 4
Winter semester 2000	Organic Chemistry II	1, 2, 3, and 4
Fall semester 2000	Organic Chemistry I	1 and 2
Winter semester 2001	Organic Chemistry I	1 and 2
Fall semester 2001	Honors Organic Chemistry I	1, 2, 3, and 4
Chemistry Is in the News Conference at MU, September 2001		
Winter semester 2002	Organic Chemistry I	1, 2, 3, 4, and 5
Winter semester 2003	Organic Chemistry II	1, 2, 3, 4, and 5
Fall semester 2003	Organic Chemistry Survey	1 and 2
Winter semester 2004	Organic Chemistry I	1, 2, 3, 4, and 5
Chemistry Is in the News Workshop at Biennial Conference on Chemistry Education, July 2004		
Fall Semester 2004	Organic Chemistry Survey	1, 2, 3, and 4

Table 3. Students' comments about *Chemistry Is in the News*

Incorporating these articles and facts is very important. It makes use wiser and [more mature] people. I don't want to be a person who only knows textbook facts, I want to know how things work around us, how chemistry is involved in our lives. And it seems like [you're] trying to do that, showing us that there is more to learn than just what a textbook has in it. (Charles)
The best part of the course, I can say, is when we had the opportunity to actually make our own 'Chemistry Is in the News' Project with our groups. It was fun in the sense that we not only learned about team work, but the main idea was to use the Internet to find articles relevant to Chemistry. This is very important since finding out how the classroom material we learn actually applies to everyday life, and technology is a big part of this learning process. (Mona)
Though at the beginning it seemed like a lot of work, I realize now how much it was worth it. In conversation I can recall facts and statistics about current scientific issues. I can explain new techniques for suturing corneas. What I came away from your class with was a confidence in my ability to talk, think, and reason as a scientist. For the first time I related science to life and came away with a deeper love for it. (Allison)
I learned a great deal about myself… how I study and don't study [haha] … and the experience even extrapolated into my everyday life outside of chemistry. I think that from the experience I've become a stronger and more disciplined student. (Tracie)

experience (Table 3). The comments provided are from e-mails sent to the faculty member by students. The first e-mail was sent during the course of the semester, but the later three were sent after the semester was completed. Additional student testimony and data relating to students' evaluation of the *Chemistry Is in the News* project and the course as a whole were collected through *Chemistry Is in the News* surveys, and the data and an analysis will be presented elsewhere (Hume, et al. 2005).

The third challenge is compelling other faculty members to implement the *Chemistry Is in the News* curriculum. The taxonomy has played an essential role in accomplishing this. It provides a structured entrance into the *Chemistry Is in the News* program, from which the program can be implemented in part or in full. The ability to use *Chemistry Is in the News* increments dissipates the fear that this project will be overwhelming for the faculty and for the students. It also eases the transition from the traditional class format to the *Chemistry Is in the News* class format. The first conference introducing faculty to the *Chemistry Is in the News* project was held in fall 2001 and such conferences have since been offered regularly. As a result of this dissemination activity, additional faculty members have implemented *Chemistry Is in the News* up to level 2, and one faculty member has implemented levels 1–3.

For full implementation of the taxonomy, it is necessary to convince faculty members of the validity of the entire *Chemistry Is in the News* curriculum. The progress in this arena has been promising. Level 5 has been achieved through collaboration with Dr Susan Schelble at the University of Colorado-Denver. Level 6 is currently being pursued with several faculty members on other continents.

Funding has provided the opportunity to professionally examine the impact of this quickly maturing curriculum on student learning. The results of these investigations

of *Chemistry Is in the News*'s impact have provided constructive feedback through which evolutionary improvements have been possible, and reports of these results will be forthcoming.

Conclusion

Educators, researchers and administrators agree about the value of students' drawing connections between chemistry and the real world. Drawing these connections serves both as an end of chemical education and as a means to facilitate learning. We reviewed various approaches that have been used to accomplish this goal; more recently, such approaches rely more and more on online media. We have proposed a taxonomy of 'authentic news media-based learning activities' to provide a conceptual framework for the description of one such approach that uses online media. Ideally, one wants to engage the students in a full range of cognitive skills and the various levels of the *Chemistry Is in the News* project can meet this challenge.

These *Chemistry Is in the News* activities serve several purposes. First, the activities make connections between organic chemistry and societal issues and problems explicit, and they require students to think critically about these connections. They provide an authentic learning task in which students are actively engaged with the course content. Second, the activities increase communication and interaction among students and between students and the instructor, making a large lecture course seem less impersonal. Third, the activities provide an opportunity for development of skills central to scientific inquiry and valuable for students' educational and career goals (e.g. collaboration, communication, research skills). Overall, the *Chemistry Is in the News* activities create a more effective learning environment within a large lecture course, and in doing so they promote students' learning of organic chemistry.

Supplementary Material

Tables that list news article information, issues addressed, related chemistry topics and chapter theme for each chapter for the texts by Bruice (SM1) and by Wade (SM2).

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Note

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