Teaching Chemistry at a Technical College Using a Non-Traditional Textbook

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Abstract

Students of agricultural technologies frequently question the requirement to take one or more general chemistry courses, and are often unable to generate the interest and motivation necessary to effectively learn and apply the required chemical topics to their programs of interest. To enhance students' motivation and appreciation for chemistry and science in general, and to help them understand the need for these courses, a non-traditional chemistry textbook was used that presented chemistry concepts in the context of current real-world environmental and societal situations, while keeping the development of chemical theory to a minimum. Results of this limited study showed that there was little improvement in students' performance, based on analysis of final course grade distributions, with the use of a non-traditional, and interesting, chemistry textbook.

Introduction

The Agricultural Technical Institute (ATI), a division of the College of Food, Agricultural, and Environmental Sciences of The Ohio State University, offers two-year Associate of Science (AS) degree programs for students intending to transfer to a four-year baccalaureate program, and two-year Associate of Applied Science (AAS) degree programs for students intending to enter the job market directly after graduation. Educational programs at ATI include Business Management, Crop Management and Services, Turfgrass Management, Laboratory and Environmental Science, Dairy Cattle Production and Management, Beef and Sheep Production and Management, and several others related to either plant or animal sciences.

ATI has an open enrollment policy, and all students at ATI, regardless of their program of interest or degree option, are required to successfully complete a one-quarter, introductory general chemistry course. Depending on their program of interest, many of the students are also required to enroll in a second chemistry course that focuses on organic chemistry and biochemistry. These courses serve as a foundation for other technical courses required by the various academic programs (e.g. soils courses for plant-related programs, nutrition courses for animal-related programs). These courses are presented at technical, non-science major level.

For 14 quarters, I have taught the Chemistry T131 course required for all AAS students. Also, I have taught the Chemistry T132 course, taken by some of the students, a total of 7 quarters. My teaching style for both courses relied primarily upon a lecture-oriented presentation, with the topics of each lecture paralleling selected sections from the textbooks for the courses. I regularly encouraged students to ask questions if they needed clarification on a topic, and I also regularly posed questions to students during topical presentations.

For the first four years (12 quarters of T131, 6 quarters of T132) I used two textbooks (Hill, et al., 1997 and Ouellette, 1992) that employed a traditional, theory-oriented approach to presenting general chemistry. Both of these books were written at a non-science major, science-related major level. During these four years a large portion of my students arrived with very little interest in, or motivation for learning chemistry, and left with very little appreciation for the significance of science and chemistry in their programs of interest or in their lives. With a lack of interest and motivation, student attendance regularly decreased dramatically after about three weeks into each quarter. Not surprisingly, student performance in general in terms of final course grades suffered accordingly.

My objective for this study was to determine if the students' appreciation for, and hence their performance in, learning chemistry could be improved by using a more non-traditionally styled chemistry textbook (Stanitski, et al., 2000). This book, written at a non-science major level and used for my two most recent quarters of teaching, is non-traditional in that it presents chemistry concepts in the context of several current environmental and societal dilemmas, such as global

warming, water quality, alternative energy sources, and genetic engineering. The book discusses these and several other issues in terms of their political and economic impacts on society, with a minimum of chemical theory encountered as needed to explore and explain the science and chemistry of these issues.

Methods

In order to evaluate the effectiveness of using this non-traditional book for T131, I compared the final course grade distributions for 482 students in nine quarters who used the traditionally-styled textbooks to the grade distributions for 98 students in two quarters who used the non-traditionally styled book. Also, for T132, I compared the final course grade distributions for 156 students in five quarters who used the traditionally styled textbooks to the grade distributions for 40 students in one quarter who used the non-traditionally styled book. Figure 1 for T131 and Figure 2 for T132 show these comparisons graphically.

For both courses, I assigned numerical values of 4, 3, 2, 1, 0 for final course grades of A, B, C, D, F, respectively. I then compared the students' grade distributions for the two styles of book using the independent t-Test at a 95% confidence level (Microsoft Excel version 2000). For T131, using an independent t-Test at a 95% confidence level, I also compared changes in the percentages of students in each grade category. Because of a limited amount of data, I did not make a similar comparison of the individual grade categories for T132. Since I considered my first year of teaching chemistry at ATI to have been a learning experience in terms of presenting material and evaluating student performance, I did not include the final course grades for this period of time in the data (three quarters of T131, 1 quarter of T132).

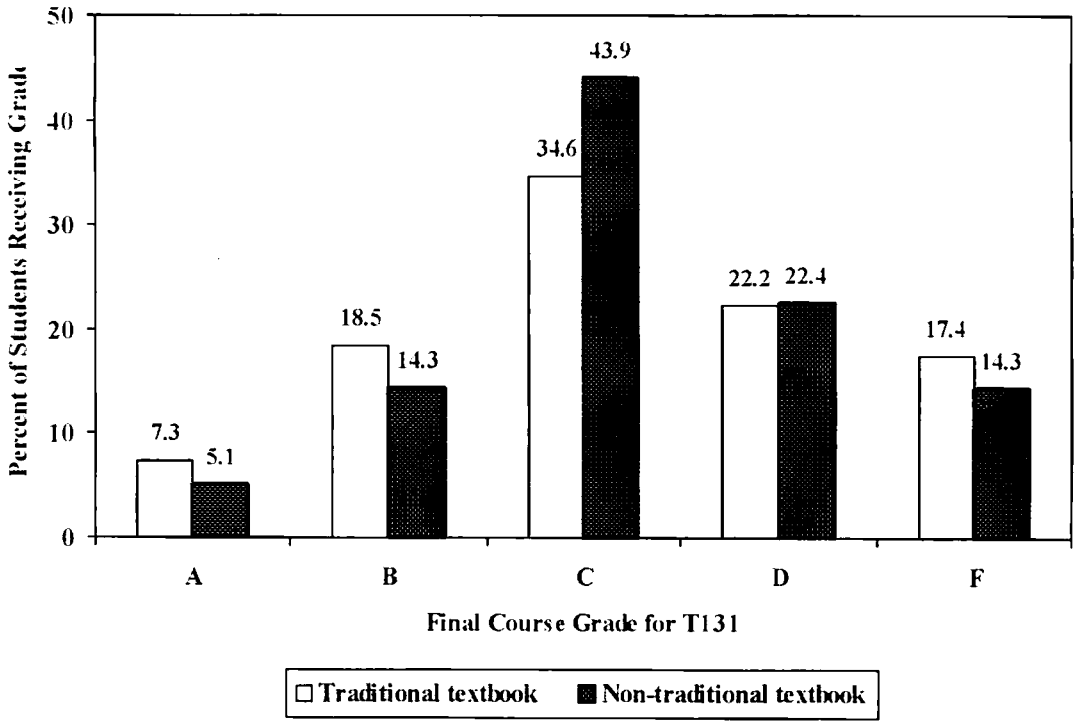

Figure 1. Distributions of final course grades for students in General Chemistry T131. The traditionally-styled textbook was used with 482 students in nine quarters; the non-traditionally styled book was used with 98 students in two quarters. Numbers above the bars indicate the percentages of students assigned each grade.

Results and Discussion

Figure 1 shows the *absolute* percentages of final grades assigned for the T131 course using the two differently-styled textbooks. Even though there are apparently sizable differences in several of the grade categories, the t-Test results (Table 1) show that there is no difference (P>0.05) between these two grade distributions. In other words, using the non-traditional book had no significant impact on altering students' performance.

However, from the information presented in Figure 1, the *relative* changes, from traditional textbook to non-traditional textbook, in these percentages are: A 30%, B 23%, C 27%, D 1%, and F 18%. Table 2 shows t-Test results for comparing differences in each grade category. Use of the non-traditional book resulted in a greater percentage of students receiving a C grade (P=0.02). Possible reasons for this increase could be that 1) the non-traditional book was less appealing or challenging to the better students since As and Bs appeared to have decreased (P>0.05), 2) the book was more appealing to the poorer students since Es also appeared to have decreased, or 3) a combination of these two effects.

Figure 2 shows the absolute percentages of final course grades for T132. The relative changes are: A 51%, B 48%, C 15%, D 1%, and E 16%. Similar to the results for

Table 1. Summary of t-Test statistics of final course grade distributions for General Chemistry T131, comparing the use of a traditionally-styled textbook to that of a non-traditionally styled book.

	Grade Assigned	A	B	C	D	E	
	Corresponding Numerical Value	4	3	2	1	0	Total Students
Traditional Textbook	Number of Students Receiving Grade	35	89	167	107	84	[z]482
	Numerical Mean for Grade Distribution	1.76					
	Variance in Distribution	1.34					
Non-Traditional Textbook	Number of Students Receiving Grade	5	14	43	22	14	[y]98
	Numerical Mean for Grade Distribution	1.73					
	Variance in Distribution	1.08					
	Difference in Means	−0.03					
	[x]P Value	1.00					

[z]Total of 482 students in 9 quarters
[y]Total of 98 students in 2 quarters
[x]t-Test: independent pairs, 95% confidence level, P is two-tail probability.

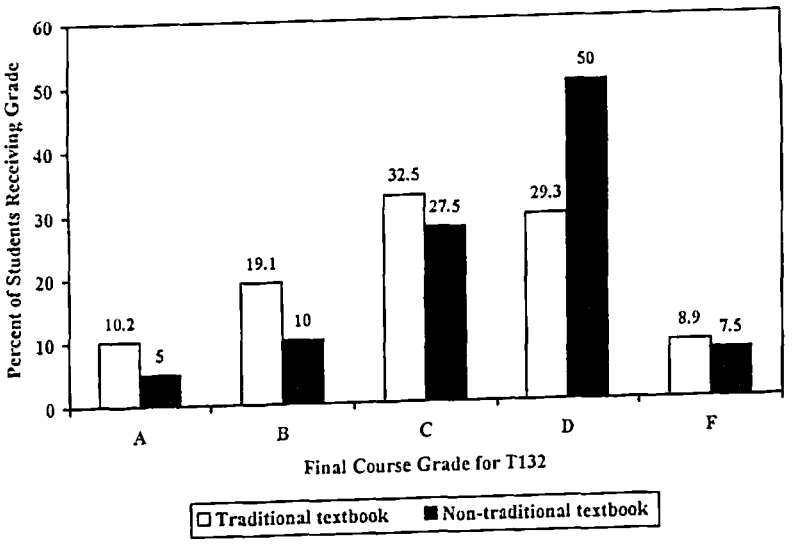

Figure 2. Distributions of final course grades for students in General Chemistry T132. The traditionally-styled textbook was used with 156 students in five quarters; the non-traditionally styled book was used with 40 students in one quarter. Numbers above the bars indicate the percentages of students assigned each grade.

Table 2. Summary of t-Test statistics of final course grade categories for General Chemistry T131, comparing the use of a traditionally-styled textbook to that of a non-traditionally styled book.

	Grade Assigned	A	B	C	D	E	Total Students
Traditional Textbook	Number of Students Receiving Grade	35	89	167	107	84	[f]482
	Percent of Total Students	7.3	18.5	34.6	22.2	17.4	
	Mean Percent for Nine Quarters	7.2	18.2	33.8	23.3	17.5	
	Variance in Mean	16.7	46.1	61.5	115	77.8	
Non-Traditional Textbook	Number of Students Receiving Grade	5	14	43	22	14	[g]98
	Percent of Total Students	5.1	14.3	43.9	22.4	14.3	
	Mean Percent for Two Quarters	5.1	14.4	43.3	22.8	14.4	
	Variance in Mean	0.015	0.73	21.5	9.3	0.73	
	Difference in Means	−2.1	−3.8	+9.5	−0.48	−3.1	
	[h]P Value	0.96	0.99	0.020	1.00	0.99	

[f] Total of 482 students in 9 quarters
[g] Total of 98 students in 2 quarters
[h] t-Test: independent pairs, 95% confidence level, P is two-tail probability.

T131, the non-traditional book may have been less appealing to the better students, possibly correlated with large decreases in As and Bs (P>0.05). Even though the t-Test results in Table 3 may support a significant difference between grade distributions (P=0.065), the limited amount of data, especially for the non-traditional book, could make these results questionable.

Effects of the non-traditional textbook on student appreciation for science and chemistry were subjectively evaluated based on informally solicited comments. For both the T131 and T132 chemistry courses, many students offered positive comments about the non-traditional book, in terms of timeliness of the topics and relevance of chemistry to real-world situations, which very rarely happened when using a traditionally styled book. A very few of the students thought that the non-traditional book was too politically oriented.

Summary

While the importance and necessity of acquiring some level of understanding of chemistry should be obvious to most students of agricultural technologies, the challenge remains to convince many of them. The attempt to do so by using a non-traditional textbook that related chemistry to contemporary issues, in order to stimulate interest and willingness to study and learn chemical concepts, resulted in no clear improvement in students' performance.

Literature Cited

Hill, J.W., S.J. Baum, and D.M. Feigl. 1997. Chemistry and life. 5th ed. Upper Saddle River, NJ. Prentice-Hall, Inc.

Ouellette, R.J. 1992. Introduction to general, organic, and biological chemistry. 3rd ed. New York, NY. Macmillan Publishing Company.

Stanitski, C.L., L.P. Eubanks, C.H. Middlecamp, and W.J. Stratton. 2000. Chemistry in context: applying chemistry to society. 3rd ed. American Chemical Society. Boston, MA. McGraw-Hill Higher Education.

Table 3. Summary of t-Test statistics of final course grade distributions for General Chemistry T132, comparing the use of a traditionally-styled textbook to that of a non-traditionally styled book.

	Grade Assigned	A	B	C	D	E	Total Students
	Corresponding Numerical Value	4	3	2	1	0	
Traditional Textbook	Number of Students Receiving Grade	16	30	51	45	14	[z] 156
	Numerical Mean for Grade Distribution	1.92					
	Variance in Distribution	1.27					
Non-Traditional Textbook	Number of Students Receiving Grade	2	4	11	20	3	[y] 40
	Numerical Mean for Grade Distribution	1.55					
	Variance in Distribution	0.92					
	Difference in Means	-0.37					
	[x] P Value	0.065					

[z] Total of 156 students in 5 quarters
[y] Total of 40 students in 1 quarter
[x] t-Test: independent pairs, 95% confidence level, P is two-tail probability.