Student Use (and Non-Use) of Instructional Software*

Amy Michel Roskowski, Richard M. Felder, and Lisa G. Bullard
North Carolina State University

After thirty years of failing to live up to the promises of its proponents, instructional technology has finally started to play an effective role in science, mathematics, engineering, and technology education. Course web sites are routinely created with copies of lecture notes, multimedia supplements, and links to other relevant sites. Many textbooks now come bundled with CD-ROMs containing multimedia demonstrations, computational tools, and interactive tutorials, and texts that do not have such resources find themselves at a competitive disadvantage. Students in courses delivered entirely with technology have begun to outperform students in traditional lecture-based courses, a trend that will most likely accelerate with time.[1]

While the ability of instructional technology to enhance learning is increasingly clear to educators, students do not necessarily rush to embrace it whenever it is introduced to them. Quite the contrary! While few SMET students are outright technophobes, many with limited computer backgrounds and many others contemplating excessive workloads are reluctant to embark on new courseware learning curves. The problem is that if the courseware is really effective, their failure to use it could lower their work efficiency and/or hurt their academic performance.

This paper reports the results of a study that illustrates student resistance to instructional technology and describes a successful approach to overcoming it. An instructional and computational software package was introduced in an introductory engineering course and the frequency of student use of the courseware was recorded. The original intention was to correlate student performance in the course with courseware usage, but the results were inconclusive because most of the students virtually ignored the courseware. In the following year a second attempt was made in which the students had to use the courseware in several early homework problems and questions about it were included on the first two tests, but only to an extent that accounted for 0.1% of the course grade. The objective of the study was to determine the effect of these relatively minor instructor interventions on the students' use of the courseware and their attitudes toward it.

Description of the Study

The introductory chemical engineering course at North Carolina State University (CHE 205 – Chemical Process Principles) covers basic engineering calculations, material and energy balances on non-reactive and reactive chemical processes, equations of state for ideal and non-ideal gases, and elementary phase equilibrium calculations. The course text, *Elementary Principles of Chemical Processes* by R.M. Felder and R.W. Rousseau,[2] comes bundled with a CD-ROM courseware package called *Interactive Chemical Process Principles* (ICPP) that consists of a set of six interactive instructional tutorials covering the major topics in the text, an algebraic and differential equation-solving program called *E-Z Solve*®, a physical property database that (among other things) automates certain tedious thermodynamic calculations, and a multimedia *Visual Encyclopedia of Chemical Engineering Equipment*®.

In the Fall 1999 semester, 150 students were enrolled in CHE 205, and in the Fall 2000 semester 138 students were enrolled. In each semester, the course was offered in two sections taught by different instructors. The students were able to access ICPP either by installing it on their own computers (as 85% in 1999 and 95% in 2000 did) or running it in an easily accessible campus computer lab. In 1999, the students were assigned to use each ICPP tool no more than once and the instructors provided no additional incentive or encouragement to use the courseware. In 2000, the instructors assigned the first two instructional tutorials and homework problems that required the use of E-Z Solve and the physical property database, announced that they planned to ask questions about those courseware components on the first two tests, and then did so. In both semesters, students were surveyed regarding the nature and extent of their use of ICPP during the semester and their attitudes about the helpfulness of the different ICPP components. The return of usable surveys in the 1999 offering was 102/150 (68%) and that in the 2000 offering was 117/138 (85%). There was no overlap among the instructors who taught in 1999 and those who taught in 2000, so there is no meaningful way to compare student performance outcomes (such as course grade distributions) from one year to the next.

Survey results

At the conclusion of each semester, the students were asked to state how often they used the courseware and each of its components. Table 1 shows the frequency distributions of the responses and Figure 1 shows the incidence of regular or frequent use (i.e., much greater use than the tests and assignments required). The percentage of students who said they used the courseware regularly or frequently rose by an order of magnitude from 6% in 1999 to 61% in 2000, the percentage who worked through more than two tutorials rose from 28% to 64%, the

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percentage who regularly used *E-Z Solve* when it was not required rose from 34% to 96%, and the percentage who regularly used the physical property database when it was not required rose from 39% to 82%. The percentages of students using the *Visual Encyclopedia*—whose use was not strongly encouraged in either year—were roughly the same and relatively low in both years.

When the students were asked to rate their comfort level with computers, 5.9% of the respondents in the 1999 class and 0.8% of those in the 2000 class initially reported themselves to be uncomfortable, and the percentages respectively dropped to 0.8% and 0% by the end of the semester. The observed differences in courseware use from one year to the next were thus almost certainly attributable to the instructors' proactivity in 2000 rather than to a greater inclination of the student population to use technology, a conclusion supported by the low use of the *Visual Encyclopedia* in 2000.

The students were also asked to rate the value of the courseware in helping them to solve homework problems and to understand course concepts. The results are shown in Table 2. The percentages of students giving favorable ratings to the helpfulness of the instructional tutorials, *E-Z Solve*, and the physical property database each increased by a factor between two and three from 1999 to 2000; the percentage who thought the courseware enabled them to save time increased from 18% to 85%, and the percentage who believed that *ICPP* helped their performance in the course increased from 9% to 64%.

Discussion and Conclusions

The underlying question of this study is, what can instructors do to persuade students to overcome their natural reluctance to expend time and effort on new course material (in this case, new instructional software). The literature on motivating adult learners provides a framework for interpreting the study outcomes. According to the *Time Continuum Model of Motivation*,[3] there are three periods in any learning process that call for different motivational strategies.

- In the beginning of the process, learners are affected both by their *attitudes* toward the new material and their perceived *need* for it. If the initial attitudes are negative, the instructor should focus on countering the negativity while attempting to enhance the students' awareness of the importance of the material in meeting their needs and goals (e.g., doing well in the course, or dealing efficiently and effectively with problems beyond the course).
- During the process, the learners are motivated by the *stimulation* provided by the new material and the *affect* (emotional content) of their experience with it. The instructor's goal should now be to make working with the material as interesting, helpful, and satisfying as possible.
- At the end of the process, the primary motivating factors are the students' *competence* in the use of the material and the *reinforcement* of incentives to keep using it. The instructor should do everything possible to promote the students' awareness of their mastery of the material and of what that mastery enables them to do that they could not do before.

We believed at the outset that *Interactive Chemical Process Principles* would be very helpful to the students as both an instructional aid and a tool to make computation and problem solving more efficient. When we administered the survey in 1999, we were surprised to find that with few exceptions, the students ignored the courseware except for the few times they were assigned to use it, and many ignored it even then. Viewed in the light of the time continuum theory, however, the result is not at all surprising, since none of the elements that affect motivation positively were in place in the 1999 course offerings. The students had negative *attitudes* toward the new courseware, as they would have had to anything that imposed additional time demands on their already overloaded schedules, and nothing was done to give them a sense that the courseware would meet any of their perceived *needs*. The cause was effectively lost at that point. Its loss was assured when nothing was done to make using the software *stimulating* or *affectively satisfying* in any way or to bring out the students' *competence* in its use or to *reinforce* its use beyond the course.

The dramatically increased use of the courseware in 2000 is also consistent with predictions of the time continuum theory. The negative *attitudes* of the students toward the additional time demands imposed by the courseware were quite strong. The instructors countered those attitudes by giving the students a compelling *need* for the courseware by requiring its use repeatedly early in the course. Once the students' resistance to using the software had been overcome, they were *stimulated* to continue using it by the ways in which it helped them understand course concepts and complete homework assignments efficiently. Their self-perceived improved ability in the course was *affectively satisfying*, which coupled with their self-perceived *competence* in the use of the courseware (particularly E-Z Solve) *reinforced* their inclination to use it when it was no longer required, even in other courses. Figure 1 provides a dramatic illustration of the effectiveness of these motivational elements.

As everyone who has tried it knows, courseware development is an incredibly time-consuming enterprise. Producing instructional tools like the interactive tutorials in *ICPP* and the *Visual Encyclopedia of Chemical Engineering Equipment* requires many person-hours per minute of student interaction time, and bringing a computational tool like *E-Z Solve* to an adequate level of robustness and user-friendliness requires years of effort from highly skilled professionals. No matter how good the final program may be, however, the effort required to produce it is wasted if its intended users don't bother to use it. The catch phrase in the popular movie *Field of Dreams* was "If you build it, they will come." In our view, the lesson of this short study to publishers and instructional software developers is that building it may not be enough. For courseware to be worth the time it takes to develop, course instructors will have to be brought in as partners and given explicit guidelines and perhaps training in how to induce the students to use it. If that is done and the courseware lives up to its promises, the rest should take care of itself.

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Table 1. Student Use of Courseware*

	1999	2000
I used ICPP		
frequently	0.0%	10.2%
regularly	6.3%	50.8%
a few times	49.5%	35.6%
once or Twice	41.4%	3.4%
never	2.7%	0.0%
I used the instructional tutorials in ICPP as follows:		
I worked through each of them once and some of them again	4.5%	30.8%
I worked through 3,4 or 5 of them once	23.6%	33.3%
I worked through 1 or 2 of them once	58.2%	35.0%
I did not work through any of them	11.8%	0.9%
I used E-Z Solve (the equation-solving program)		
many times, both in CHE 205 and in other courses	1.8%	13.6%
many times for CHE 205 homework problems	2.7%	35.6%
a few times for CHE 205 homework problems	30.0%	46.6%
only when the instructional tutorial problems called for it	49.1%	1.7%
I never used it	16.4%	2.5%
I used the Visual Encyclopedia		
many times, both in CHE 205 and in other courses	3.6%	1.7%
many times for CHE 205 homework problems	1.8%	1.7%
a few times for CHE 205 homework problems	40.0%	33.1%
only when the instructional tutorial problems called for it	37.3%	40.7%
I never used it	17.3%	22.9%
I used the Physical Property Database		
many times, both in CHE 205 and in other courses	2.7%	5.9%
many times for CHE 205 homework problems	5.5%	25.4%
a few times for CHE 205 homework problems	30.9%	50.8%
only when the instructional tutorial problems called for it	40.9%	15.3%
I never used it	20.0%	2.5%

* **Categories shown in boldface type represent usage well beyond that required in assignments.**

Table 2. Student-Assessed Helpfulness of the Courseware

	1999	2000
Working through the instructional tutorials helped me solve subsequent homework problems		
Disagree	11.9%	3.4%
Neutral	45.9%	33.9%
Agree	**21.1%**	**57.6%**
Didn't Use	21.1%	5.1%
Working through the instructional tutorials improved my understanding of course concepts		
Disagree	5.5%	1.7%
Neutral	40.4%	21.2%
Agree	**32.1%**	**71.2%**
Didn't Use	22.0%	5.9%
Using EZ Solve made problems solving easier		
Disagree	14.7%	0.0%
Neutral	29.4%	4.2%
Agree	**35.8%**	**93.2%**
Didn't Use	20.2%	2.5%
Referring to the Visual Encyclopedia made problem statements clearer		
Disagree	3.7%	3.4%
Neutral	45.0%	39.8%
Agree	**22.0%**	**28.0%**
Didn't Use	29.4%	28.8%
Using the Physical Property Database made problem solving easier		
Disagree	5.5%	0.0%
Neutral	33.0%	13.6%
Agree	32.1%	79.7%
Didn't Use	29.4%	5.9%
Having ICPP available saved me time		
Disagree	22.0%	2.5%
Neutral	45.9%	11.0%
Agree	18.3%	84.7%
Didn't Use	13.8%	1.7%
Having ICPP available helped my performance in the course		
Disagree	30.3%	5.3%
Neutral	47.7%	28.9%
Agree	9.2%	64.0%
Didn't Use	12.8%	1.8%

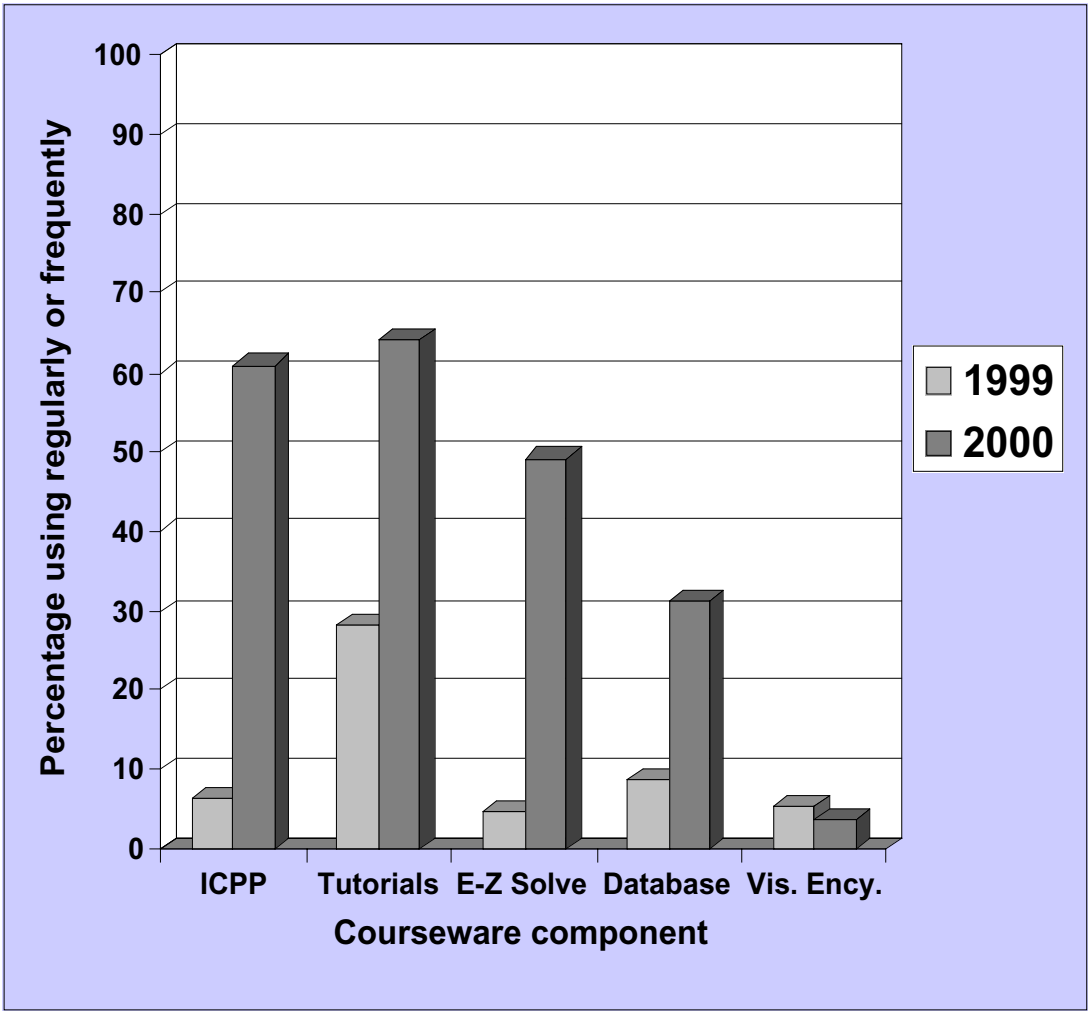

Figure 1. Courseware usage beyond required assignments.

Dr. Amy Michel Roskowski

completed her PhD. in Chemical Engineering in 2001 at North Carolina State University in the area of GaN semiconductor growth and characterization. She received her undergraduate degrees in Mechanical Engineering and Chemistry from Ohio Northern University. She is currently working for Intel Corporation in Portland, Oregon as a senior process engineer.

Dr. Richard M. Felder

is Hoechst Celanese Professor Emeritus of Chemical Engineering at North Carolina State University, Raleigh, North Carolina. He is coauthor of *Elementary Principles of Chemical Processes* (3rd Edition, John Wiley & Sons, 2000) and over 200 papers on engineering and science education and chemical process engineering. Since 1991 he has co-directed the National Effective Teaching Institute under the auspices of the American Society for Engineering Education.

Dr. Lisa Bullard

is a Visiting Assistant Professor and Coordinator of Undergraduate Advising in the Department of Chemical Engineering at North Carolina State University. She is a graduate of North Carolina State (BS ChE '86) and Carnegie Mellon University (PhD ChE '91). She held various engineering and business positions at Eastman Chemical Company in Kingsport, TN before joining the faculty at N.C. State in 2000. Her interests include multidisciplinary process design, teaching effectiveness, undergraduate advising, and educational outreach to K-12.