

## INSTRUCTIONAL SOFTWARE: IF YOU BUILD IT, THEY MAY OR MAY NOT COME

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### ABSTRACT

Student use of an instructional and computational software package for the introductory chemical engineering course was investigated in four separate course offerings in two semesters. In two offerings in the Fall of 1999 the courseware was demonstrated and included in an early homework assignment, with no further action begin taken to encourage its use, and in the two Fall 2000 offerings the students had to use the courseware in several early homework problems and questions about it were included on tests. The fact that the students used the courseware more in the second semester offerings is not surprising, but the extent of the difference in usage is. With very few exceptions, the students in the first semester largely ignored the courseware, while those in the second semester used it extensively (far more than was required) and gave it highly positive ratings in a course-end survey, even though its use directly accounted for only about 0.01% of the final course grade. However instructive and visually attractive software may be, the cost of developing and producing it is wasted if its intended beneficiaries ignore it. The lesson of this study is that instructors who wish to make effective use of courseware must be proactive about getting their students to use it: simply making it available is not enough.

### INTRODUCTION

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. It is a 4-credit course comprising three lecture hours and a two-hour recitation session every week and is normally taken in the first semester of the sophomore year.

The course uses the textbook *Elementary Principles of Chemical Processes* by R.M. Felder and R.W. Rousseau.<sup>1</sup> The latest edition of the text comes bundled with a CD-ROM courseware package called *Interactive Chemical Process Principles* (ICPP) developed by one of the text authors in conjunction with Intellipro, Inc. The package consists of (a) a set of six interactive instructional tutorials covering the major topics in the text, (b) a simple-to-use but powerful algebraic and differential equation-solving program called E-Z Solve, (c) a physical property database that (among other things) automates the tedious calculation of enthalpy changes for heating and cooling processes, (d) a multimedia *Visual Encyclopedia of Chemical Engineering Equipment* developed by Dr. Susan Montgomery of the University of Michigan, and (e) the

*Index of Learning Styles*, a self-scoring instrument that assesses learning style preferences on a model devised by Felder and Silverman.<sup>2</sup>

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. In 1999, the students were assigned to use each ICPP tool no more than once and no particular encouragement to use the courseware was subsequently given. In 2000, both professors assigned homework problems that required the use of E-Z Solve and the physical property database, announced that they planned to include test and quiz questions that asked specifically about those components and material in the instructional tutorials, and then did so. In both semesters, students were surveyed regarding their comfort level with computer applications, the nature and extent of their use of ICPP during the semester, and their attitudes about the helpfulness of the different ICPP components. Of the 150 students in the 1999 offering, 102 (68%) were able to access the software and returned usable surveys, and the return in the 2000 offering was 117/138 (85%). Our goal was to determine the effect of the instructor's proactivity in encouraging the use of the courseware on the extent of the students' use of the courseware and their subsequent attitudes about it.

### **Students' comfort level with computer applications**

The students were asked to rank their comfort level at the beginning and end of the semester. At the beginning 5.9% of the 1999 class and 0.8% of the 2000 class reported themselves to be uncomfortable with computers, and the percentages dropped to 0.8% and 0%, respectively, by the end of the semester. We concluded that differences in courseware use from one year to the next could not be attributed to differences in comfort levels with computer applications.

The students were able to access the courseware by either installing it on their own computers or by using the CD on computers in an easily accessible computer lab. Many students reported installing the software on their own computers (85% in 1999 and 95% in 2000). In 1999, there were problems with installing the software on school computers, but many of the students who did not have their own computers were able to access the courseware on computers belonging to their classmates. The school access problem was eliminated for the 2000 semester.

### **Courseware Usage**

At the conclusion of both the 1999 and 2000 semesters the students were asked to state how often they used the courseware and each of its separate components. Table 1 shows the frequency distributions of the responses.

The most notable difference in the 1999 and 2000 survey results is the tenfold increase from 6% to 61% in the percentage of students using the courseware frequently or regularly. The tools used most by the 2000 students were the instructional tutorials, E-Z Solve, and the physical property database—not coincidentally, the tools whose use was required or strongly encouraged by the instructors in the 2000 course offerings. The percentage of students who worked through more than two tutorials rose from 28% to 64%, the percentage who ever used E-Z Solve when it was not required rose from 34% to 96%, and the percentage who ever used the physical property

database when it was not required rose from 39% to 82%. The percentages using the Visual Encyclopedia and the Index of Learning Styles—whose use was not strongly encouraged in either year—were roughly the same and relatively low in both years.

### **Student-Assessed Helpfulness of the Courseware**

The students were 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 believing that ICPP helped their performance in the course increased from 9% to 64%.

### **Discussion and Conclusions**

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 quite surprised to find that the students virtually ignored the courseware except for the few times they were assigned to use it, and many of them ignored it even then. Our hypothesis was that the course instructors would have to be much more proactive to get the students to use the courseware enough to begin to see its benefits for themselves. We believe that this study has amply validated this hypothesis.

Instructional technology is coming to be considered an increasingly vital component of higher education in the coming decades, particularly with the rise in importance of distance education. As anyone who has ever tried it knows, however, developing courseware is an extremely costly operation in time or money or both. Producing instructional software like the 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 several years of effort from highly skilled professionals. No matter how good the final program may be, however, the money and effort required to produce it are 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 can live up to its promises, the rest will take care of itself.

#### **Bibliography**

1. R.M. Felder and R.W. Rousseau, *Elementary Principles of Chemical Processes*, 3<sup>rd</sup> Edn., New York, John Wiley & Sons, 2000.
2. R.M. Felder, "Reaching the Second Tier: Learning and Teaching Styles in College Science Education," *J. College Science Teaching*, 23(5), 286–290 (1993).

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Lisa Bullard is a Visiting Assistant Professor in the Chemical Engineering Department at North Carolina State University. She joined the faculty in 2000 after ten years of industrial experience at Eastman Chemical Company. A registered professional engineer, Dr. Bullard's interests include multidisciplinary design, teaching effectiveness, and undergraduate advising.

**Table 1. Student Use of Courseware**

Survey	1999	2000
<b>I used ICPP</b>		
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%
<b>I used the instructional tutorials in ICPP as follows:</b>		
I did not work through any of them	11.8%	0.9%
I worked through 1 or 2 of them once	58.2%	35.0%
I worked through 3,4 or 5 of them once	23.6%	33.3%
I worked through each of them once and some of them again	4.5%	30.8%
<b>I used E-Z Solve (the equation-solving program)</b>		
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%
<b>I used the Visual Encyclopedia</b>		
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%
<b>I used the Physical Property Database</b>		
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%
<b>How did you use the Index of Learning Styles?</b>		
I never used it	8.3%	11.9%
I completed the instrument but did not seek additional information about the results	29.4%	21.2%
I completed the instrument and read the descriptions of the learning styles	54.1%	55.9%
I completed the instrument and read the descriptions and additional material on the Web	8.3%	11.0%

**Table 2. Student-Assessed Helpfulness of the Courseware**

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