ChemPrep: A Self-Paced, Online Preparatory Course for General Chemistry

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Abstract:
ChemPrep was developed to be a stand-alone preparatory short-course to help students succeed in general chemistry. It is web-based and delivered using the OWL system. Students reported that the *ChemPrep* materials (short information pages, parameterized questions with detailed feedback, tutorials, and answers to questions through the OWL message system) permitted them to work independently without the need for textbook or lecture. On average, students who completed *ChemPrep* had higher grades in the subsequent GenChem, Nursing and Honors courses, with a greater percentage achieving a grade of C- or higher. Participation in *ChemPrep* was voluntary, and more women than men responded. Students in the Honors course enrolled in *ChemPrep* in higher percentages than students in GenChem and Nursing. SAT and math placement exam scores were used as proxy measures of prior achievement/ability. Based on these, Honors *ChemPrep* users were on par with their peers but performed better in the course than non-users. In GenChem and Nursing, *ChemPrep* helped students of high prior achievement/ability perform better than their achievement scores would predict. Weaker/less motivated students did not respond to the voluntary offerings of *ChemPrep* in the same numbers as stronger/more motivated students, and we are seeking alternate ways to reach this population.

Keywords:
First-Year Undergraduate/General, curriculum, Internet/Web-based learning, distance learning/self instruction, nonmajor courses,

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ChemPrep is a self-paced, non-credit course designed to help students prepare for general chemistry[1,2,3]. It is delivered via the internet using the OWL (Online Web-based Learning) system[4] developed at the University of Massachusetts Amherst (UMass), and students complete the course before the beginning of the semester *(1)*. *ChemPrep* was created in response to a need we saw to improve students' overall preparation and opportunity for success in general chemistry. Currently at UMass, about 70% of students who enroll in the general chemistry course for science majors complete it with a grade of C- or better. Many science tracts use general chemistry as a "gatekeeper" course with advancement contingent upon "success", as measured by a minimum grade. Consequently, a large number of students, 30% or more, either retake general chemistry or exit from science-based majors. Many students thus register for general chemistry with trepidation, unsure of their ability to succeed.

Students enter general chemistry with a wide range of backgrounds and experiences. As with many large research institutions, UMass offers three different levels of general chemistry. In the large-enrollment course for science majors (GenChem), some students have completed high school advanced placement chemistry (AP), others have returned to school with a myriad of career experiences but very little chemistry background and weak math skills, and the bulk of the

students are first and second-year science majors who have experienced high school chemistry and math courses of widely varying quality. In the course for nursing majors (Nursing), scientific abilities tend to be lower, with fewer students having AP credit and advanced math classes. In the honors/chemistry majors course (Honors), students usually enter with a strong background in high school chemistry, often AP, and many welcome the opportunity to prepare in advance for a fast-paced college-level course.

To address this diversity of backgrounds and experiences, *ChemPrep* was developed as a self-paced preparatory course to help students review concepts, fill in content gaps, build confidence, and strengthen mathematical skills. Our goal is to offer students an enhanced opportunity for success in general chemistry. Students are allowed as much time as needed to master the material, prior to the start of the semester, with no penalties or grades attached. Because there are many different chemistry instructors teaching a number of different sections of GenChem, Nursing, and Honors courses, the material covered in *ChemPrep* is generic enough to prepare students for the breadth of content and emphases they will encounter in their general chemistry classes.

Online Preparatory Courses

Online courses are available to help students prepare for standardized college entrance exams such as the ACT and SAT tests, as well as for graduate and professional school exams (MCAT, GRE). While these courses have proven quite effective at boosting test scores by teaching exam taking strategies *(2-4)*, they are not necessarily designed to help students learn a subject but, rather, to hone a set of skills for a very specific end—performing well on an exam.

A variety of web-based activities also exist that can be used to help prepare students for general chemistry, but these are stand-alone materials outside the context of a course and require a fair amount of effort on the part of the instructor to integrate *(5)*. Activities like these may lack the extensive feedback and help structures designed to guide student learning. General chemistry students at the University of Iowa take an online placement examination to assess preparedness and determine placement into one of three introductory chemistry sequences *(6)*. These students also use a set of online math-based tutorials at the beginning of the course.

ChemPrep was constructed to be a comprehensive, stand-alone system with high-quality content and feedback. Because we wanted an environment in which students could work in the absence of a text or lecture, one challenge was to create a narrative to take the place of these resources. We used the strengths of the OWL system — information pages, mastery learning, and parameterization of numbers, chemical systems, and feedback, to provide the backbone. We were also able to use the OWL system to deliver the course free of charge, and for this we thank the University of Massachusetts. Without these resources, *ChemPrep* would have been prohibitively expensive to develop and deploy.

The OWL System

OWL (Online Web-based Learning) is an electronic learning environment originally created as a joint project between the Chemistry and Computer Science Departments at UMass *(7-14)*. Student activities are supported by an authoring environment for the creation of instructional materials and by a set of course management tools, all of which are web-based. OWL is currently used by over 20 departments on the UMass campus in disciplines ranging from physics and chemistry to resource economics and art history[5]. *OWL: General Chemistry* and

OWL: Organic Chemistry are licensed and distributed by Thomson Learning - Brooks/Cole Publishing and are used on over 150 college and university campuses nationwide.

OWL for General Chemistry is based on the mastery principle, where students work until they master chemical concepts using homework problems, interactive simulations, exercises, and tutors. The extensive database of homework questions is parameterized both numerically and chemically, so that students can attempt a question multiple times and see a variation of the basic question each time. A detailed solution specifically parameterized to each problem is provided as soon as the student submits an answer for evaluation. This type of instant, answer-based feedback has been shown to help students build confidence with the course material in a non-threatening (and non-testing) environment *(15)*.

ChemPrep and its Implementation

ChemPrep covers six topics that we have identified as prerequisite knowledge for a traditional general chemistry course (Table 1).

Table 1: ChemPrep Topics for General Chemistry

1.	The Structure of Matter
2.	Naming Chemical Compounds
3.	Measurement and Calculations
4.	Calculations involving Quantities of Matter
5.	Chemical Reactions
6.	Math Skills

Each unit contains short information pages to present a concept or activity. Questions that follow develop a topic in the form of detailed feedback. Occasional interactive tutors or

simulations allow students an alternative method of learning. Students are encouraged to use the OWL message system to ask questions or submit comments as they proceed through the material, although few take advantage of the opportunity. Messages are answered by an instructor, usually within 24 hours of submission. Our students report that this combination of resources permits them to work at their own pace without the need for a textbook or lecture.

Prior to the beginning of each semester in July and January, all students pre-registered in GenChem, Nursing, or Honors chemistry courses are invited to participate via email. Students work at their own pace, accessing the materials through a web browser. They have until the first day of classes to complete the work and their progress is recorded in the OWL system. The entire course takes approximately 20 hours.

Our aim as we designed the course was to allow students with a strong high school background to move quickly through the material, focusing on areas where they might have some gaps. Students who have not had a comprehensive chemistry course in high school or have not had high school chemistry for a number of years could use *ChemPrep* more systematically to strengthen their foundation in the skills needed for general chemistry. *ChemPrep* includes some of the quantitative aspects of chemistry and was designed to help students build confidence in their mathematical abilities. Thus it was hoped that students would start the semester on a more equal footing, regardless of background.

Study Design and Results

The off-sequence section of first semester general chemistry (GenChem) in Spring 04 was chosen to be our first pilot group (373 students). Students responded more enthusiastically than anticipated and eighty-three signed up for *ChemPrep* in December and January. Twenty-

eight of them completed more than 50% of the modules (Table 2). The progress of these students was monitored in the subsequent course. Online surveys were conducted at the end of both courses.

In the following tables "users" are defined as those students who completed more than 50% of the *ChemPrep* modules, and "non-users" as those who did not sign up for the course. Students who signed up for *ChemPrep* but completed less than half of the work were not included in the analysis below, but further studies will examine the effects on this group. Of those students who were designated as users, all did a substantial amount of the work but only about half actually completed the entire course.

Table 2: Numbers of *ChemPrep* Users and Students by course

	Total Students	Signed Up	Users (>50% completed)	Users (percent of total)
GenChem S04	373	83	28	8%
GenChem F04	658	203	61	9%
Nursing F04	180	62	16	9%
Honors F04	115	52	26	23%
Total	1326	400	131	10%

For Spring 04, the average grade[6] of *ChemPrep* users was 3.00, while the average grade of nonusers was 2.10 (Table 3). Anecdotal evidence (surveys, comments) also suggested that the participants found the course helpful. Based upon these promising results *ChemPrep* was offered to all students enrolled in any of our introductory general chemistry courses for the fall of 2004. As in the previous semester, participation in *ChemPrep* was entirely voluntary and students completed the material before the start of classes, during July and August. All students were presented with the same *ChemPrep* material; no modifications were made for the different courses or from the spring semester to the fall.

Once again only a small percentage of GenChem students and an equal percentage of Nursing students (9%), actually completed *ChemPrep* (Table 2). For those in the Honors course however, use levels reached 23%, an interesting difference in participation that will be discussed later in this paper. Again, about half of the users completed all of the OWL work, and the average grades of users versus nonusers were higher (Table 3).

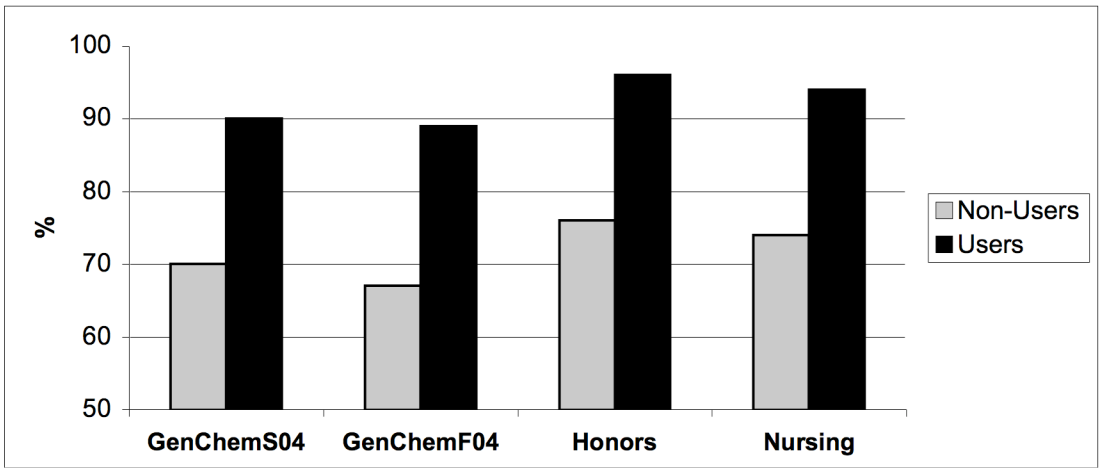
Table 3: Average Grades of *ChemPrep* Users and Non-users

	N Non-users	N Prep users	Grade Non-users	Grade Users	p value of diff.	Effect size
GenChem S04	290	28	2.10	**3.00**	0.000	0.73
GenChem F04	455	61	2.26	**3.04**	0.000	0.62
Nursing F04	118	16	2.62	**3.75**	0.000	1.01
Honors F04	63	26	2.91	**3.36**	0.033	0.46

For Nursing students, *ChemPrep* users scored, on average, a full letter grade higher than non-users. For GenChem students, the difference was slightly less than this. Even for our Honors students, there was almost a half of a letter grade difference between users and non-users. In all cases, the differences between user and non-user performance were statistically significant, being highly significant ($p < 0.01$) in all but the Honors course.

The percentage of students completing the course with a grade of C- or better, which we defined as the rate of success in the class, was also examined. Historically, our success rates in the introductory chemistry courses have fallen between 65-75%. As shown in Figure 1, success rates for the *ChemPrep* users were much higher.

Figure 1: Success Rates of *ChemPrep* Users and Non-users



Is *ChemPrep* Really Responsible for the Grade Differences?

As shown in Table 2, over 1300 students had access to *ChemPrep* in the spring and fall semesters of 2004. The question is, did the *ChemPrep* course really improve student grades in the class, especially among those students who would otherwise have been struggling, or was this simply a case of the better students self-selecting into *ChemPrep* ? Given that the course was entirely voluntary, students who participated in *ChemPrep* were more motivated, for whatever reason, to make use of this resource. The question then becomes how would this higher level of motivation have affected their grades in the absence of *ChemPrep*—in other words, would they have performed better than the non-users anyway, even without *ChemPrep*, and, if so, by how much ?

In order to determine whether stronger students were self-selecting into ChemPrep, we used math and verbal SAT I scores, and the algebra and trigonometry scores on the University's Math Placement exam, as proxy measures for the students' prior achievement and ability. Pearson correlation coefficients between these measures and grades for each course are reported in Table 4, with statistical significance indicating that higher scores on the predictors are

associated with better grades in the class. The predictor values correlate significantly with class performance in all but three cases (Honors SAT Verbal and Math scores and the Nursing SAT I verbal score).

Table 4. Correlations Between Predictor Variables and Grades

Course	Pearson correlation coefficients between course grades and…				N
	SAT I - Math	SAT I - Verbal	Math Placement - Algebra	Math Placement - Trigonometry	
GenChem S04	0.540**	0.374**	0.461**	0.410**	313
GenChem F04	0.218**	0.143**	0.297**	0.277**	584
Nursing F04	0.316**	0.133	0.433**	0.397**	147
Honors F04[7]	0.070	0.060	0.222*	0.345*	112

* indicates that the correlations are significant at the 0.05 level (2-tailed).
** indicates that the correlations are significant at the 0.01 level (2-tailed).

We used the *effect size* for each of these measures as a standardized method of comparison. *Effect size (ES)* is defined as the difference between the average score of user and non-user groups, divided by the standard deviation of the total class.

$$\textit{Effect Size} = \frac{\textit{(Avg Score User - Avg Score Non-user)}}{\textit{(Standard Deviation Class)}}$$

$ES = 0$, No difference between groups

$ES < 0$, Users weaker than Non-users

$ES > 0$, Users stronger than Non-users

Effect sizes with absolute values around 0.2 are considered small, 0.5 moderate, and 0.8 large by social science researchers *(16-17)*. As shown in Table 3, the effect sizes of all of the grades are positive and they range from moderate to large, indicating that there are meaningful grade differences between users and non-users in all of the courses.

In order to determine if the differences in grades were solely attributable to the difference in student strength we calculated the effect sizes for the SAT and Math Placement scores, our

proxy measures for prior achievement and ability (Tables 5 and 6). Small effect sizes for these measures would indicate that there is little difference in aptitude between user and non-user groups and would be evidence that the higher grades of users were due to the *ChemPrep* course.

Table 5: Differences in SAT I Scores Between *ChemPrep* Users and Non-users

	SAT Math						SAT Verbal					
Class	N Non-users	N Users	Avg Non-users	Avg Users	P Diff	**Effect Size**	N Non-users	N Users	Avg Non-users	Avg Users	P Diff	**Effect Size**
GenChem S04	268	28	578	598	0.09	**0.23**	268	28	547	575	0.08	**0.35**
GenChem F04	424	59	581	585	0.71	**0.05**	424	59	549	585	0.00	**0.44**
Nursing F04	104	16	532	578	0.02	**0.64**	104	16	518	536	0.35	0.24*
Honors F04	63	27	661	641	0.28	-0.27*	63	63	610	607	0.91	-0.03*

*Scores do not correlate well with grades (see Table 4) and are not used in further analysis

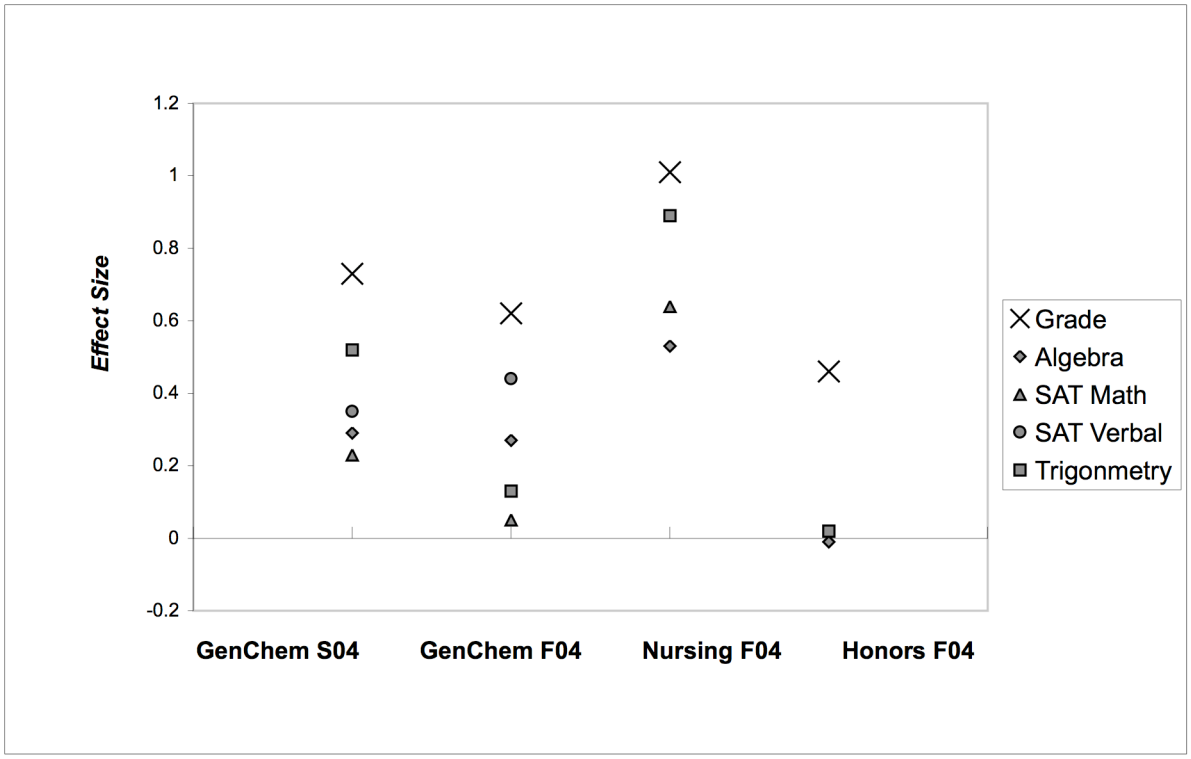
Table 6: Differences in Math Placement[8] Scores Between *ChemPrep* Users and Non-users

	Algebra						Trigonometry					
Class	N Non-users	N Users	Avg Non-users	Avg Users	P Diff	**Effect Size**	N Non-users	N Users	Avg Non-users	Avg Users	P Diff	**Effect Size**
GenChem S04	246	29	20.4	22.1	0.14	**0.29**	246	28	4.7	6.1	0.01	**0.52**
GenChem F04	411	62	21.4	22.8	0.05	**0.27**	411	62	4.9	5.2	0.34	**0.13**
Nursing F04	94	16	17.4	20.3	0.07	**0.53**	94	16	3.4	5.4	0.00	**0.89**
Honors F04	65	27	25.6	25.6	0.97	**-0.01**	65	27	6.9	7.0	0.95	**0.02**

As Tables 5 and 6 show, GenChem and Nursing users of *ChemPrep* were in fact academically stronger than non-users, having higher predictor variable scores on all measures ($ES > 0$). For Honors there was not a significant difference between users and non-users in the two variables that correlated well with course grades, Math Placement Algebra and Trigonometry ($ES \sim 0$). This is to be expected since this is a more homogenous, academically stronger group overall.

A comparison of the effect sizes of grades and prior achievement/ability measures for each class is shown in Figure 2. The SAT and Math Placement effect size values define a range in which we would expect the value for the course grade to fall if *ChemPrep* had little or no influence on student performance. Because the SAT scores for Honors, and SAT verbal for Nursing, do not correlate well with student grades (see Table 4), we do not include these values in Figure 2.

Figure 2: Effect Size of Course Grades, SAT I and Math Placement Scores



For every course, the effect size for the grade was higher than those of the prior achievement/ability measures. While the students in GenChem and Nursing who elected to do *ChemPrep* tended to be stronger than their peers ($ES > 0$ for SAT and Math Placement), they also appeared to benefit beyond what would be predicted by their entry skills. The *ChemPrep*

course appears to have had a positive effect over and above the advantage these students brought to the course.

In the Honors course, there does not appear to be a significant difference between users and non-users based on predictors of prior achievement/ability, but there is a large difference in grade performance. Here, there seems to be a substantial positive relationship between *ChemPrep* usage and course grades. This was a surprising result because the Honors group was stronger overall and we had expected there to be, at best, a small increase in course grades for users. We were also surprised by the fact that a much larger percentage of Honors students completed *ChemPrep* (23% *vs.* 9% for GenChem and Nursing). If we assume that this group has a larger proportion of motivated students then this result is reasonable.

While the data for effect size support the hypothesis that *ChemPrep* helped students over and above what would be expected from their previous work, it is notoriously difficult to tease out motivational factors and the data do not unequivocally show a cause-effect relationship. Other motivational factors, such as more time spent on task, may be contributing. We have not been able to devise a good measure of this using OWL because login time does not necessarily translate into actual study time. Anecdotal data from surveys suggest that the stronger students actually spend less time doing homework.

Who Benefited from ChemPrep?

The data suggest that students who completed *ChemPrep* were, in general, strong academically, and the grades of these students in subsequent courses were positively influenced over and above what would be predicted from measures of prior achievement or ability. This is

especially interesting because one would expect that these are the students who would need, or benefit from, a preparatory course the least.

We can identify three types of general chemistry student who would voluntarily choose to participate in *ChemPrep*:

1) Those who know they are unprepared and are likely do poorly without additional help.
2) Those who are likely to do well but lack confidence in their preparation.
3) Those who probably will do well and make use of every resource available.

The course was primarily designed for the first type of student. However it appears that most of the users actually fell into the latter two categories. For these students, *ChemPrep,* with its detailed feedback and mastery approach to learning, appears to have helped develop or refresh the content knowledge needed to perform well. In addition *ChemPrep* may also have helped these students build confidence with the technology used in the subsequent courses. These students *are likely to succeed anyway*, and *ChemPrep* seems to have offered a tool to improve their performance.

Based upon our design and intent for the course, it is our expectation that students of lower prior achievement/ability levels would also benefit from *ChemPrep*. Our challenge is to help these students identify their deficiencies and to convince them to take advantage of this resource.

Gender Differences

ChemPrep users were more likely to be women, 73% compared to 53 % of all students taking general chemistry (Table 7).

Table 7: Percent of Female Students by course

	%Female Total	%Female Users	%Female Non-users
GenChem S04	41	**66**	36
GenChem F04	53	**72**	46
Nursing F04	80	**94**	74
Honors F04	51	**69**	43
Overall	53	**73**	46

Through surveys conducted in our general chemistry classes over the past five semesters, a consistent pattern has emerged: women students rate the importance of outside resources such as the textbook, study groups, help center, websites, tutoring, etc., more highly than men. None of the differences on individual items reached a level of statistical significance, but the pattern is consistent across all items. Thus, women are more likely to take advantage of various sources of help than are men, and their over representation among *ChemPrep* users is indicative of this. This is also consistent with the idea that the students who participated in *ChemPrep* were from the second and third groups mentioned above. For these students, the online course may have helped to build a framework for success. Given the under-representation of women in the physical sciences, the *ChemPrep* model may point out a creative new way to reach female students.

How Can We Encourage Greater *ChemPrep* Usage?

It appears that we have reached many of those students who are predisposed to take advantage of preparation materials to boost their confidence, study skills, and content knowledge. However, we have not necessarily reached those students who are most unprepared and will do poorly without extra help.

This summer (2005) we are working directly with advisors in the New Students Program, the Honors College, Engineering, and Nursing to inform incoming students about *ChemPrep*. We have developed a brochure to hand out during orientation and over 800 of these have been distributed as of this writing. Advisors within each discipline are best positioned to encourage participation and they have received *ChemPrep* with great enthusiasm. We are keen to see if these steps will increase the voluntary participation rate.

As briefly described above *(5)*, educators at the University of Iowa have approached the problem of identifying weaker students by creating an online chemistry exam that assesses student readiness and points out relevant web resources. We expect that a similar approach will be effective for *ChemPrep* and OWL software engineers have begun work to develop an online testing capability that is able to diagnose a student's level of content readiness and assemble a curriculum subset of modules that is tailored to each student's need. As shown in Table 2, many students signed up for *ChemPrep* but did not complete at least half of the material. These students may have benefited from such a diagnostic instrument to help them pinpoint specific weaknesses and address them more efficiently.

As a result of feedback given on our surveys, we are also investigating whether three different versions of *ChemPrep* should be developed for GenChem, Nursing, and Honors courses. The main question is whether a curriculum that is more specifically customized to each course would be more likely to encourage participation. Different versions of *ChemPrep* might also adapt more readily to courses at other institutions.

Conclusions

ChemPrep was developed to be a stand-alone preparatory program to help students succeed in general chemistry. Students reported that the combination of short information pages, parameterized questions with detailed feedback, tutors, and answers to questions through the OWL message system, permitted them to learn independently without the need for a textbook or lecture. Students who completed *ChemPrep* had higher success rates and, on average, higher grades in GenChem, Nursing and Honors courses. The initial offerings of *ChemPrep* were entirely voluntary, and more women than men participated. *ChemPrep* appears to have helped students of high prior achievement/ability perform better than their achievement scores predicted. Students in the Honors course enrolled in *ChemPrep* in higher percentages than students in GenChem and Nursing. Honors users were not necessarily better students than their peers, but performed better in the course than those students who did not use *ChemPrep*. Weaker/less motivated students did not respond to the voluntary offerings of *ChemPrep* in the same numbers as stronger/more motivated students, and we are seeking alternate ways to reach this population. Further research involving the *ChemPrep* course as it compares to learner styles is underway.

A companion study of the preparatory course for organic chemistry showed a similar improvement in the performance of users versus non-users in the subsequent courses. This study will be the subject of a separate paper.

The preparatory course model should be appropriate for any discipline that requires a certain amount of background knowledge, especially in the sciences and mathematics. It could also benefit students in a variety of situations, including those at two- and four-year institutions. The UMass Provost's Office has used *ChemPrep* as the basis for a proposal to develop a

university-wide program to improve success in first-year physics and calculus courses among others. There are clear long-term benefits to helping more students successfully complete their entry-level science and math studies, both in terms of reducing the number of students who take extra time to complete their degrees, and in terms of retaining more students in science-related majors. We believe that the *ChemPrep* model holds great promise to help improve this situation for students of general and organic chemistry.

Notes

1. Funding for this project was provided by the Professional Development Grant Program of the University of Massachusetts Information Technology Council.

2. A companion self-paced online preparatory course for organic chemistry has also been developed and tested. The results of this study will be presented in a subsequent paper.

3. Information about the ChemPrep courses for both General and Organic chemistry can be found at http://www.chem.umass.edu/chemprep (accessed July, 2005)

4. A demonstration of the OWL system delivered through Thomson Learning can be found at http://owl.thomsonlearning.com/demo (accessed July, 2005).

5. Examples of the OWL courses delivered at UMass Amherst can be found at http://owl.oit.umass.edu (accessed July, 2005).

6. Grades are based upon a 4.0 scale, with 4.0 indicating an A and 0.0 an F.

7. Correlations in the Honors class are lower due to the selectivity of the course, which resulted in a restriction of range in the predictor variables.

8. The University's math placement exam is given to all entering first-year students and used for placement into the appropriate math course. It has two components: algebra and trigonometry.

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Table 1: ChemPrep Topics for General Chemistry

1. The Structure of Matter
2. Naming Chemical Compounds
3. Measurement and Calculations
4. Calculations involving Quantities of Matter
5. Chemical Reactions
6. Math Skills

Table 2: Numbers of *ChemPrep* Users and Students by course

	Total Students	Signed Up	Users (>50% completed)	Users (percent of total)
GenChem S04	373	83	28	8%
GenChem F04	658	203	61	9%
Nursing F04	180	62	16	9%
Honors F04	115	52	26	23%
Total	1326	400	131	10%

Table 3: Average Grades of *ChemPrep* Users and Non-users

	N Non-users	N Prep users	Grade Non-users	Grade Users	p value of diff.	Effect size
GenChem S04	290	28	2.10	**3.00**	0.000	0.73
GenChem F04	455	61	2.26	**3.04**	0.000	0.62
Nursing F04	118	16	2.62	**3.75**	0.000	1.01
Honors F04	63	26	2.91	**3.36**	0.033	0.46

Table 4. Correlations Between Predictor Variables and Grades

Course	Pearson correlation coefficients between course grades and…				N
	SAT I - Math	SAT I - Verbal	Math Placement - Algebra	Math Placement - Trigonometry	
GenChem S04	0.540**	0.374**	0.461**	0.410**	313
GenChem F04	0.218**	0.143**	0.297**	0.277**	584
Nursing F04	0.316**	0.133	0.433**	0.397**	147
Honors F04[7]	0.070	0.060	0.222*	0.345*	112

* indicates that the correlations are significant at the 0.05 level (2-tailed).
** indicates that the correlations are significant at the 0.01 level (2-tailed).

Table 5: Differences in SAT I Scores Between *ChemPrep* Users and Non-users

	SAT Math						SAT Verbal					
Class	N Non-users	N Users	Avg Non-users	Avg Users	P Diff	**Effect Size**	N Non-users	N Users	Avg Non-users	Avg Users	P Diff	**Effect Size**
GenChem S04	268	28	578	598	0.09	**0.23**	268	28	547	575	0.08	**0.35**
GenChem F04	424	59	581	585	0.71	**0.05**	424	59	549	585	0.00	**0.44**
Nursing F04	104	16	532	578	0.02	**0.64**	104	16	518	536	0.35	0.24*
Honors F04	63	27	661	641	0.28	-0.27*	63	63	610	607	0.91	-0.03*

*Scores do not correlate well with grades and are not used in further analysis

Table 6: Differences in Math Placement[8] Scores Between *ChemPrep* Users and Non-users

	Algebra						Trigonometry					
Class	N Non-users	N Users	Avg Non-users	Avg Users	P Diff	**Effect Size**	N Non-users	N Users	Avg Non-users	Avg Users	P Diff	**Effect Size**
GenChem S04	246	29	20.4	22.1	0.14	**0.29**	246	28	4.7	6.1	0.01	**0.52**
GenChem F04	411	62	21.4	22.8	0.05	**0.27**	411	62	4.9	5.2	0.34	**0.13**
Nursing F04	94	16	17.4	20.3	0.07	**0.53**	94	16	3.4	5.4	0.00	**0.89**
Honors F04	65	27	25.6	25.6	0.97	**-0.01**	65	27	6.9	7.0	0.95	**0.02**

Table 7: Percent of Female Students by course

	%Female Total	%Female Users	%Female Non-users
GenChem S04	41	**66**	36
GenChem F04	53	**72**	46
Nursing F04	80	**94**	74
Honors F04	51	**69**	43
Overall	53	**73**	46

Figure 1: Success Rates of *ChemPrep* Users and Non-users

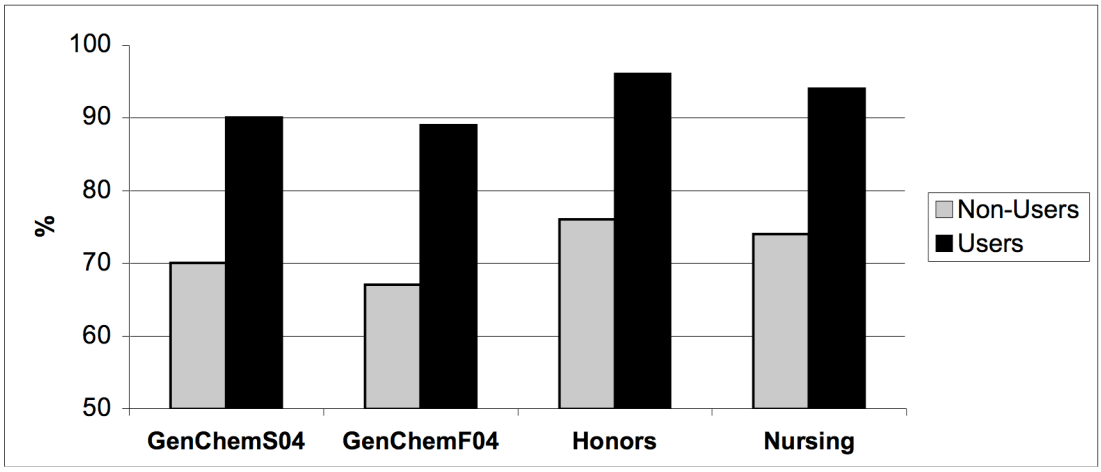

Figure 2: Effect Size of Course Grades, SAT I and Math Placement Scores