Studio Chemistry: Combining laboratory and lecture into one space  
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Science is the belief in the ignorance of experts. - Richard Feynman

A "Chemistry Studio Classroom" combines lecture and lab activities into one space, and encourages students to learn science through a continuous cycle of observation, reasoning, and experiment. Starting with the observation of physical phenomena, students begin to create their own ideas, leading to discussions, further experiments, and new observations to refine and construct scientific understanding. The Studio Classroom makes it possible for students to perform experiments, work in small groups, share data, participate in discussions, observe demonstrations, listen to mini-lectures, and switch easily between all of these activities, all from the same seat. For more information, including before and after pictures, visit http://faculty.ccc.edu/cabrams/studio

Seven Principles of Good Practice in Teaching - Chickering & Gamson
Encourage contact between students and faculty
Develop reciprocity and cooperation among students
Encourage active learning
Give prompt feedback
Emphasize time on task
Communicate high expectations
Respect diverse talents and ways of learning

Are you considering building a chemistry studio classroom?

Architects and engineers can be helpful consultants, but do not let them take over your decision making. (See Feynman’s quote above.) Only a chemistry teacher knows the best way to design a room for teaching chemistry. A faculty-centered design process is essential! You should have a clear vision of what you want, lots of time, and a willingness to manage all of the details. Having some light construction experience is very helpful – e.g. renovating your basement. You should be present or visit often during all construction, and do not hesitate to express any concerns to the general contractor. Be prepared to do some minor construction yourself (e.g. drilling holes, connecting computers).

Visit other studio classrooms and ask for advice. Keep enrollment the same as traditional classrooms. Start the design with a 30:1 (1 ft = 1 cm) foam-core model of the bare room, and scale models of the furniture to try different arrangements. Bring the model to all meetings, especially with administrators. With furniture contractors, insist on talking with engineers or drafters directly if you are designing something new. The sales representative may not understand what you are trying to do, and mistranslate for the engineers or try to push you towards what is in their catalog. Justify all of your design elements with pedagogical goals, including creating a comfortable, relaxing work environment for your students. Do not be afraid of colors! Track all orders at each step, and keep copies of requisitions, POs, invoices.

Hardware - Teacher station
Applied Computer Systems - LINK Composite classroom management system
Microscope with AverMedia document camera
ELMO document camera
SmartBoard
Audio amplifier with ceiling mounted speakers
DVD/VCR
Sheet feed scanner
Logitech QuickCam
Four way switch

Other Hardware
Goggle sterilizer
Drying oven
Microwave ovens
Hewlett Packard laser printer
Hewlett Packard dc7800p Small Form Factor desktop computers
Viewsonic VSI 120 flat panel monitor
Belkin USB grommet
Ergotron articulating monitor mount
PASCO probes (pH, temperature, pressure, etc.)
Ocean Optics UV/VIS spectrometers
Ocean Optics RedTide spectrometers
Shimadzu QP-2010 GCMS
VWR Hand pump
Hot plate stirrers
Balances with USB interface

Furniture
Raised tile floor, carpet tile
VWR ReadyShip lab benches and phenolic resin tops
Labconco ventilation hoods
KI custom designed cluster tables, composite tops, task chairs, cabinets, teacher station

Software
DataStudio (PASCO) is the primary data collection software
SpectraSuite is the data collection software for the UV-VIS and Red Tide spectrometers
NUTS is NMR data processing software
WinFirst is IR data processing software
Shimadzu GC/MS data processing software
ChemSketch is a free program for drawing chemistry structures
IR Tutor was written by Professor Abrams
NMR Tutor was written by Professor Abrams
Chemistry Comes Alive is a set of 8 CD’s with video demos (teacher station only)
Google Earth is a free program for viewing satellite images
Celestia is a free program for viewing a model of the solar system, galaxy, and universe
Stellarium is a free program that simulates the day and night sky
Windows Remote Connection to GC/MS computer
Windows Remote Connection to NMR computer
BOINC screensaver (protein folding calculations for Rosetta@Home project)
Percent of Students Passing Traditional vs. Studio Courses (C or better)

<table>
<thead>
<tr>
<th>Course</th>
<th>Traditional</th>
<th>Studio</th>
<th>Difference</th>
<th># Students in Studios</th>
<th># Sections of Studio</th>
</tr>
</thead>
<tbody>
<tr>
<td>All chemistry</td>
<td>66.1%</td>
<td>75.8%</td>
<td>9.6</td>
<td>186</td>
<td>6</td>
</tr>
<tr>
<td>Algebra</td>
<td>59.6%</td>
<td>54.4%</td>
<td>-5.2</td>
<td>331</td>
<td>12</td>
</tr>
<tr>
<td>ESL</td>
<td>57.5%</td>
<td>57.2%</td>
<td>-0.3</td>
<td>536</td>
<td>23</td>
</tr>
<tr>
<td>English 101</td>
<td>58.4%</td>
<td>58.2%</td>
<td>-0.2</td>
<td>184</td>
<td>7</td>
</tr>
<tr>
<td>English 102</td>
<td>57.7%</td>
<td>54.1%</td>
<td>-3.5</td>
<td>338</td>
<td>15</td>
</tr>
</tbody>
</table>

Number of Sections in the Chemistry Studio (opened Sp 08):

<table>
<thead>
<tr>
<th>Course</th>
<th>Fa 07</th>
<th>Sp 08</th>
<th>Su 08</th>
<th>Fa 09 (planned)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Chemistry</td>
<td>2*</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>General Chemistry I</td>
<td>1*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Chemistry II</td>
<td>1*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survey of Organic and Biochem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* only partial use of studio, or use of studio equipment but not room

Number of Faculty Teaching in Studio (out of 6 full time and 4-6 adjunct):

<table>
<thead>
<tr>
<th>Semester</th>
<th>Full time</th>
<th>2008</th>
<th>Adjunct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 07</td>
<td>2</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Spring 08</td>
<td>2</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>Fall 09</td>
<td>4</td>
<td>3</td>
<td>21</td>
</tr>
</tbody>
</table>

Several other City Colleges of Chicago now have plans for studios

Classroom Artifacts Illustrate:

- The experiments are rich with data.
- Students repeat experiments multiple times and learn from their mistakes.
- In class discussion of results leads to further, refined experimentation.
- Writing skills are integral to experiments.
- Calculations are done during experiments.
- Procedures are written by the students.

Survey for Basic Chemistry, Spring 2008 (N=17, scale 1-5)

Student Assessment of Learning Gains (SALG) instrument

Which of the following aspects of the class help your learning?

- 4.94 Taking notes while watching the computer monitor to see the professor's notes
- 4.88 Watching demonstrations on the computer monitor
- 4.82 Class presentations (including lectures)
- 4.81 The class notes online
- 4.69 The practice quizzes and exams posted online
- 4.69 The way this class was taught overall
- 4.65 Working in the chemistry studio in general
- 4.19 ALEKS homework system

... (5 other aspects of the class were rated between 4.19 and 3.81)

To what extent did you make gains in ...

- 4.35 Understanding the main concepts
- 4.35 Understanding how ideas in this class relate to those in other science classes
- 4.24 Understanding the relationship between concepts
- 4.24 Enthusiasm for subject
- 4.18 Understanding the relevance of chemistry to real world issues
- 4.18 Ability to think through a problem or argument
- 4.18 Confidence in your ability to do chemistry
- 4.00 Feeling comfortable with complex ideas

Selected comments:

"I've had a lot of fun in this chemistry class. I have to say that I wasn't so good with chem when I was in high school (and that I totally disliked the subject) but I have to say that this class made me appreciate the course even better. ... The notes posted on blackboard were also a great help for those who were absent. ..."

"I came into this class scared, told myself that it would determine whether or not I would go to med school. Well, I loved the class ...The only thing I didn't like were the labs... I have to admit...I never opened the text book all semester. The resources that [were] provided, ALEKS, and the lectures were more than enough to study with. ... Anyway, I loved the class!!"

"This class made me LOVE chemistry. It was awesome being the first class to ever use this new computer class. It was very helpful, and interesting for an early [8:00 am] class. Usually, I would be losing concentration and falling asleep, but the computers and your enthusiasm for the subject made it really fun! ..."