Next Generation Studio: A New Model for Interactive Learning

Next Generation Studio courses integrate the power and flexibility of asynchronous learning with the known benefits of studio teaching. Web sites become "virtual studio classrooms" that engage students in interactive learning, team work and communication beyond the confines of scheduled classes.

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Over the past decade a new paradigm for undergraduate education has slowly emerged as an alternative to the much maligned lecture format. Often described as student centered or inquiry-based, this new approach emphasizes hands-on, active learning and encourages students to construct their own understanding of the subject matter. Research in classrooms across the country has shown that, where such novel methods are employed, learning increases substantially.

Rensselaer Polytechnic Institute has been a leader in the ongoing transformation of undergraduate education. Recognized by numerous national awards, Rensselaer's "Studio" teaching model has become a national paradigm for effective curriculum reform. The foundation of the Studio approach is the conviction that students learn more by "discussing and doing" than by "listening and watching." The essence of Studio teaching lies in increased interaction at all levels, from peer-to-peer discussions to one-on-one exchanges between student and instructor. A typical Studio science course replaces the traditional lecture/recitation/lab, normally requiring 5-6 hours per week, with 4 hours of Studio. Instead of sitting passively in large, impersonal lecture halls, students work in teams of 3 or 4 in small, 25-45 seat computer classrooms. In a given class, a brief conceptual introduction to the day's activities is followed by exercises which engage students in guided activities. The instructor circulates through the classroom, asking and answering questions as students work on simulations, multimedia modules, Web-based exercises, problem solving, and data analyses.

An Evolving Learning Environment

Since the Studio model was developed in the early 1990s, a number of developments have precipitated fundamental changes in the process of education. Perhaps the most important has been the explosive growth of the World Wide Web. One consequence of this growth has been the wide-spread use of course web sites. These sites, combined with emerging technologies such as high speed networks, peer-to-peer communication, and streaming video, offer great promise for complementing in-class with on-line learning. During the 1990s Rensselaer and other universities around the country also began requiring students to purchase powerful laptop computers. The vast potential of these machines to

promote anywhere-anytime learning and improve on-campus education is only beginning to be realized. Another major development over the past ten years has been the sea change in our understanding of the human brain, cognition, and how people learn. It is clear that future advances in teaching and learning will depend on research results emerging from these areas.

Responding to these changes in the learning environment, the Anderson Center at RPI has developed a Next Generation Studio model that builds on the foundation of traditional studio while incorporating new methodologies and connecting research on learning with classroom practice. Next Generation Studio extends the benefits of interactive learning beyond the confines of the traditional classroom and is already improving both student learning and faculty productivity.

Development of the Model

Next Generation Studio evolved from Rensselaer's original Studio model as a result of research conducted at the Anderson Center during the 1990s. Most influential were two pilot courses that Bruce Laplante, the associate director of the Center, and I created and taught for the National Technological University. These courses, *Hands-On Multimedia* and *Hands-On World Wide Web: Spinning Your Own Site*, combined satellite broadcasts with synchronous, web-based tutoring sessions and asynchronous hands-on exercises conducted via the Internet. My aim was to emulate studio at a distance and allow off-campus students to realize the benefits of interactive learning. *Hands-On World Wide Web* was successful beyond our dreams, attracting over 8000 participants at 500 sites in the United States and Asia, an NTU record.

The methodologies developed to teach these courses came to be known as the 80/20 Model for interactive distance learning. The 80/20 Model was eventually adopted by RPI's division of distance learning and Lucent Technologies' Global Learning Solutions for its world-wide education and training program. Under funding from the Sloan Foundation, I incorporated many of the lessons learned in these pilots to create and teach Next Generation Studio Ecology and, working with the RPI math department, to produce an online version of Studio Differential Equations.

After further research and experimentation, the following components were eventually integrated to form the foundation of the Next Generation Studio model:

1. Connected learning through the integration of in-class and on-line education
2. Customized learning via content tailored to different learning styles
3. Continuous assessment of learning through diagnostic exams and online evaluations

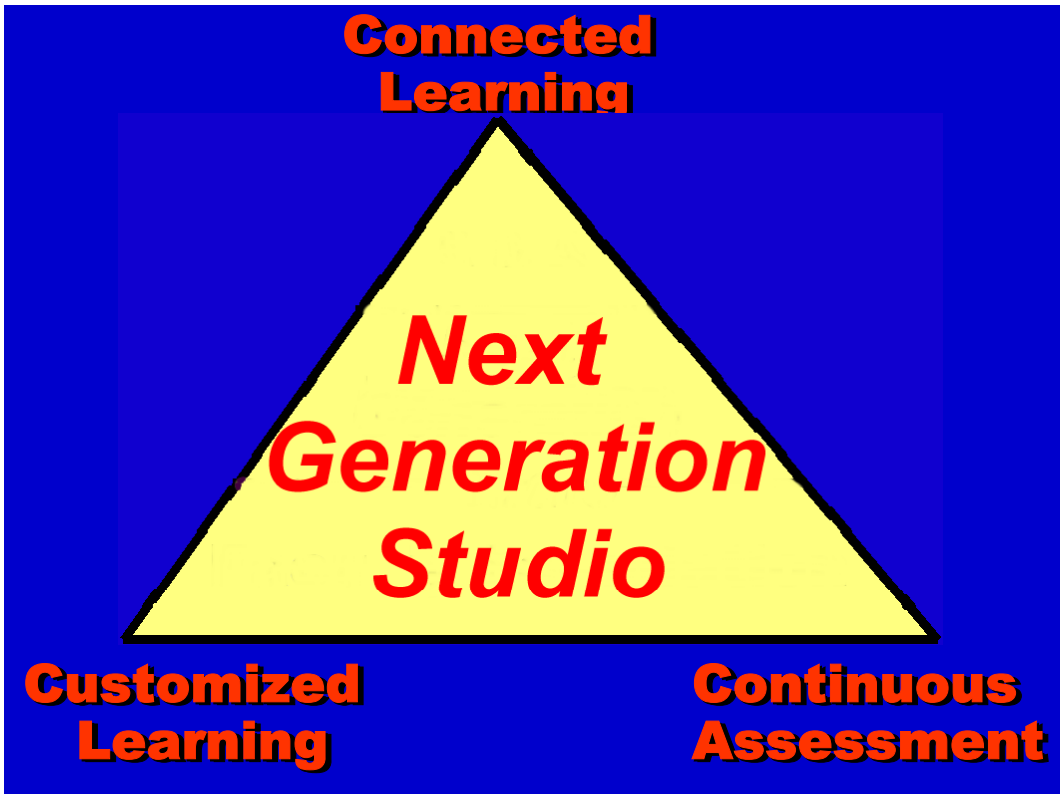

Figure 1: Components of the Next Generation Studio model.

The use of course web sites to post syllabi and other resources has become increasingly common. Next Generation Studio, however, goes far beyond these basic practices. In Next Generation Studio, web sites become "virtual studio classrooms" that engage students in interactive learning, team work and communication outside the classroom. The use of streaming video, online exercises, and electronic office hours now complements and greatly extends learning in face-to-face studio classes.

Besides leveraging the power of distributed e-learning, Next Generation Studio applies research on cognition and learning to improve both classroom and web-based instruction. In particular, Next Generation Studio courses evaluate differences in learning styles amongst students and utilize a range of teaching methods and materials to address those styles. For example, to help create the Next Generation version of Thermal and Fluids Engineering, the Anderson Center is measuring student learning styles using several diagnostic instruments. Working with the instructors, we are developing new exercises, graphics, animations and other materials that are specifically tailored to the broad spectrum of learning styles that we are finding amongst our

students. Current research indicates that we can expect a two-fold increase in learning gains by such "teaching to styles."

Continuous, formative assessment of learning outcomes is also central to realizing the goals of Next Generation Studio and the Anderson Center is currently working with several departments to create diagnostic exams and online

assessment tools. While Rensselaer has a remarkable record of innovation in teaching, further improvements in undergraduate education are dependent on an in-depth understanding of the effects of our classroom interventions. Without rigorous, scientific assessment of learning outcomes, we will inevitably waste time on unproductive innovations despite hard work and the best of intentions.

Current Progress and Future Directions

The first Next Generation courses, Studio Ecology and Web-based Differential Equations, are now integral parts of the biology and math curricula at RPI. Figure 2 shows the Online Activities page from the Studio Ecology web site. For a given topic, students start at the left hand side of the row of activities and move sequentially to the right. By following this sequence, students are taken around the *Kolb Learning Cycle*. The videos that introduce each topic provide *concrete experience* of many ecological phenomena that are inaccessible to most students. After viewing the introductory video, students are asked to make predictions about the outcomes of their online labs. This requires *reflective observation* and *abstract conceptualization*. The labs, which include EcoBeaker™ simulations accessed over the Internet via a Citrix server, facilitate *active experimentation* and *discovery learning*, the corner stones of Studio teaching. After completing their labs, students read a 1-2 page online article that pertains to the topic at hand, usually taken from the News & Views section of Nature or the Perspectives section of Science. They then engage a series of discussion questions and post their replies to the bulletin board.

These postings form the basis for discussion at the beginning of the next face-to-face class. Finally, they take an online quiz at the end of each set of online activities.

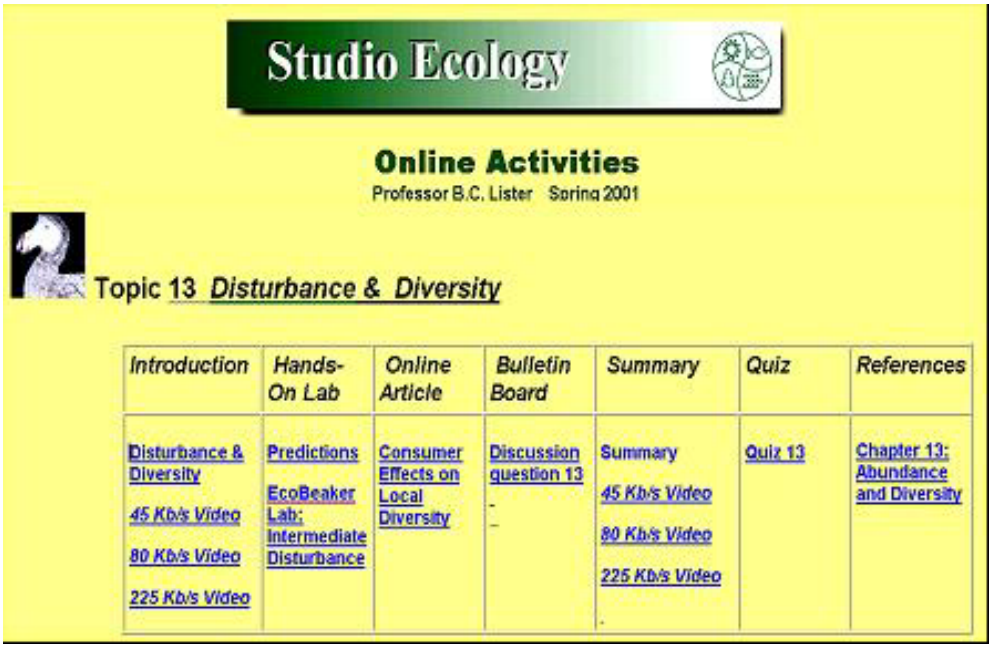

Figure 2: Part of the online activities page from the Studio Ecology web site.

After completing their asynchronous activities, students come to class much more prepared and knowledgeable, ready for in-depth discussion and interaction. Studio Ecology students rate their online learning experiences very highly (Figure 3) and, thanks to the integration of web and classroom learning, I have about 50% more time during my classes for what works best in studio: hands-on team work and active discovery. Assessment of learning outcomes and student reaction has also been encouraging in Web-based Differential Equations. Students in this course perform just as well or better than their counterparts in the traditional face-to-face studio class which is taught by the same instructor. Since the Web-based course is largely asynchronous, the instructor is about twice as productive. Finally, more than 90% of the students also felt that the web-based version was an effective way to learn differential equations.

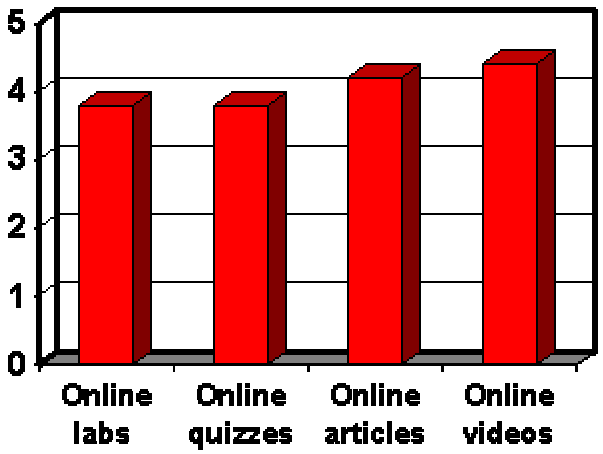

Figure 3: Student ratings of the educational effectiveness of the online materials in Studio Ecology. 1=Totally ineffective 2=Not very effective. 3=Somewhat effective. 4=Effective. 5=Very effective.

We are currently working with a number of RPI departments to produce other Next Generation Studio courses. These include Calculus, Engineering Graphics, Thermal and Fluids Engineering, and Computer Science I. Given the learning and productivity gains realized in our pilot courses, we expect the model to eventually spread throughout the curriculum and have a major impact on resident undergraduate education at Rensselaer.

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