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AUTHOR	Buckley, Donald; Coleman, William; Cohen, Martin; Stewart, Richard
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ABSTRACT

This paper reports on research that used the development of interactive multimedia learning environments as a device to allow faculty to explore principles of the Learning Paradigm. The following pedagogical feature set of this technology that resonated with faculty and that can foster transition to the Learning Paradigm is presented: (1) interactivity fosters active learning; (2) the sensory-rich nature of this technology facilitates the engagement of additional powerful cognitive processes; and (3) integration of assessment tools into the environment can provide students with feedback and encouragement, allow the collection of diagnostic clues about individual student learning needs, and enable the collection data to evaluate student learning outcomes. Examples of four kinds of learning environments (i.e., learning facts, building concepts, experiencing critical inquiry, and fostering student-originated research) developed in the Department of Biology of the University of Hartford (Connecticut) are presented to illustrate these principles. Assessment issues as they vary across this learning continuum are also explored. (MES)

Interactive Multimedia Learning Environments: Tools to Foster Transition to the Learning Paradigm.

Donald Buckley
Associate Professor of Biology
Director of Instructional Technologies, School of Health Sciences
Quinnipiac College
Hamden, CT 06518 U.S.A.
don.buckley@quinnipiac.edu

William Coleman
Professor of Biology
wcoleman@mail.hartford.edu

Martin Cohen
Professor of Biology
mcohen@mail.hartford.edu

Richard Stewart
Department of Biology
stewart@mail.hartford.edu

University of Hartford
West Hartford, CT 06117 U.S.A.

Abstract
Higher education has begun transitioning from a traditional emphasis on the delivery of content (the Instructional Paradigm) to the more demanding goal of creating powerful learning environments that meet the needs of a diverse student community (the Learning Paradigm). However, most higher education faculty have been trained as researchers, not educators in the sense of the Learning Paradigm. We have used the development of interactive multimedia learning environments as a device to allow faculty to explore principles of the Learning Paradigm. In this regard, three pedagogical features of the technology resonated with many faculty and are identified below. In addition, we illustrate a simple taxonomy of four kinds of learning environments that our faculty have developed, ranging from highly structured environments to open-ended research simulations. Lastly, we explore assessment issues as they vary across this learning continuum.

Higher education has entered a transition from the Teaching Paradigm to the Learning Paradigm. This transition results from a variety of pressures that have created a climate of pedagogical self-examination during this "Decade of the Brain." Emerging from this process are powerful new teaching styles founded on principles of active-learning and improved insights on the cognitive development of learning. In science education, where this change has been late in arriving, the educational community has embraced the principle that we must provide high quality learning experiences for all students regardless of their learning styles. However, recognizing the need for change is simpler than achieving systematic change.

At the same time, educational technology is looming as a preeminent force in higher education. Of special interest to us are learning environments that exploit interactive multimedia. The educational potential of this technology closely parallels the pedagogical goals of the Learning Paradigm. However, the adoption of these powerful tools has not advanced as rapidly as its advocates have predicted. In part, this is because the pedagogical potential of the technology is subtle to faculty untrained to exploit it. Probably the learning potential of the technology is often constrained by its mismatch with current practice. Faculty who operate within the confines of the traditional Instructional Paradigm are less likely to perceive and exploit the full learning potential of the technology. Also, the tremendous variety of learning environments seems to confuse many faculty. The pedagogical feature set of the technology is often not readily apparent and faculty frequently use the technology to "make a better lecture".

We would like to suggest a simple pedagogical feature set that resonates with many faculty and that can foster transition to the Learning Paradigm.

1. Interactivity fosters active learning,

2. The sensory-rich nature of this technology facilitates the engagement of additional powerful cognitive processes, and

3. Integration of assessment tools into the environment can provide students with feedback and encouragement, allow the collection of diagnostic clues about individual student learning needs, and enable the collection data to evaluate student learning outcomes.

We have used this tool in our own institution with such success that one half of the faculty have requested training in interactive multimedia authoring and one quarter of the faculty (74) have already undergone initial training. Subsequent surveys of faculty attitudes and technology use patterns indicate that faculty trained with an interactive multimedia authoring experience became much more optimistic about the ability of educational technology to improve student motivation and ability to learn. Although it may not be surprising that these faculty utilized interactive multimedia more in their teaching, they also used a much greater variety of educational technology with greater intensity after having had an authoring experience.

We will present examples of four kinds of learning environments developed in the Department of Biology of the University of Hartford to illustrate these principles:

1. Learning facts: "Cell Differentials". This system simulates a clinical experience in which students must classify 100 white blood cells and suggest what pathology might be indicated by this profile. This environment includes three kinds of assessment tools. To provide incentive to strive for competency, a quiz system is integrated. This grading system keeps a running mean of the last three performances, which encourages recurrent trials when necessary. Second, the instructor can enable a feedback function that informs students of the correct answer when they misidentify a cell type. Third, to provide diagnostic clues about individual student needs, two additional kinds of assessment are provided. A graphical display shows at a glance a matrix of cell type scores in the rows, with actual identities in the columns. The results are automatically saved for faculty review in a player application later. At the end of any 100 cell "lesson", a replay button can be clicked to call up a random review of all mistakes, so that the instructor and student can work closely on items with which the student may be struggling (Figure 1).

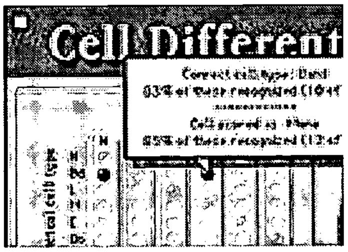

Figure 1. Practicing white blood cell identification before a wet lab.

This system is not intended to replace the wet lab. Rather it serves as a preface to even the playing field for people with different learning styles. In traditional wet labs, students examine real microscope slides in an individualistic environment (a microscope) that provides little feedback. Usually, only assertive students willing to call the instructor back again and again get substantial personal feedback.

2. Building concepts: "Eukaryotic Cell Divisions". The study of hierarchical systems, like those typical in biology, is often challenging to students because synthesis across levels of organization in a hierarchy is a demanding task. In this learning environment, content is chunked into short presentations followed immediately by assessment experiences that enable students to use the information incrementally as the content unfolds. Summary displays of student achievement are available for viewing and are automatically output to the instructor's server, as in the Cell Differentials system. Again, running means of the last three quiz grades encourage recurrent practice for those students who need it (Figure 2).

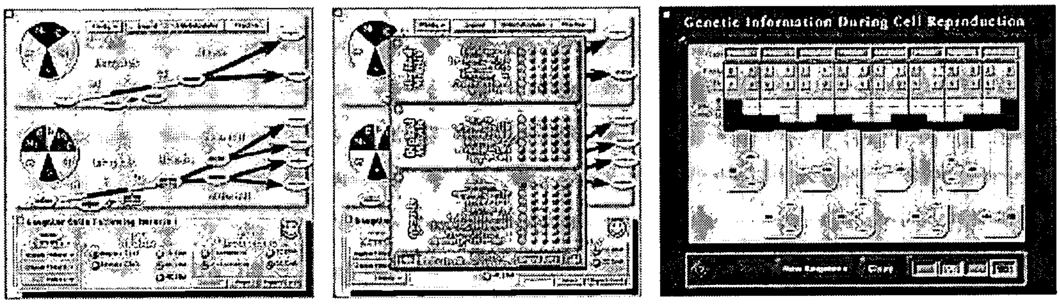

Figure 2. Exploring genetic changes in eukaryotic cell divisions to encourage students in concept-building: Assessment tools to collect diagnostic information about individual student learning needs.

This lesson was developed to give students practice in a demanding learning task. Early mean quiz grades have increased from the low 50s to the low 80s, with 90% of the students attaining a 90% proficiency within one week, compared to the mean 70% proficiency after two weeks with previous paper and pencil exercises. The effectiveness of this method has not only improved student learning outcomes dramatically, but it works so quickly that it has allowed the addition of additional course content, not the usual outcome of adopting more powerful pedagogies.

3. Experiencing Critical Inquiry: "The Search for the Hereditary Molecule". The previous two systems illustrate learning environments that are directed toward the mastery of foundational information.

Assessment tools can be developed with comparative ease for such structured learning goals. However, learning environments designed to foster the development of critical inquiry skills must be more open-ended. Students must be allowed to explore and to make mistakes more freely. Student interaction with the learning environment is of a higher order, but assessment is correspondingly more challenging.

In this research simulation, students are provided with the tools used in a famous experiment and also instructed what the basic research question was. The students are then invited to design a research program to resolve the question. We have taken two approaches to assessment. Limited structured assessment tools are provided to give students feedback about their understanding of foundational information necessary to design an insightful experiment. Assessment can assume a more reflective experience in active learning environments in which an effort is being made to transfer the authority of learning to the students. Therefore a different kind of assessment is employed to reinforce the learning experience of the more open-ended component of this system. The system actually includes several different sub-simulations that allow students to experience the inquiry in several different ways. Each of the three modules provides alternative insights about experimental design:

1. a virtual lab with emulated test tubes and petri dishes to manipulate,
2. a spreadsheet-like module that emphasizes an experimental design overview, and
3. a flow sheet in which the computer produces hypothetical realities that the student must interpret from experimental results (Figure 3).

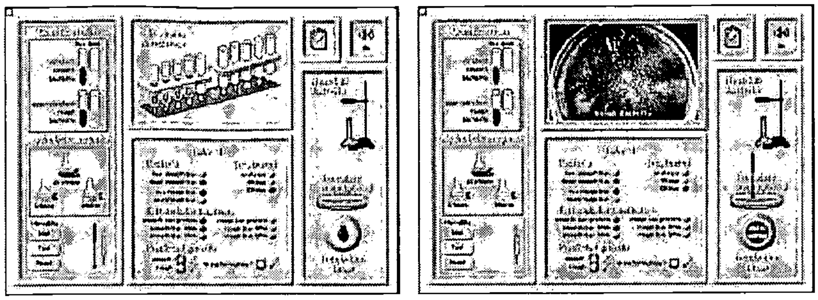

Figure 3. *The Search for the Hereditary Molecule:* A research simulation

4. Using interactive multimedia to foster student-originated research: "Developmental Selection". We have attempted to transition our introductory biology laboratory classes from traditional menus of demo-like experiences to real research experiences in which students are pursuing questions that they have originated. This is a challenging freshman experience. These young people usually lack the necessary foundational information required to originate questions. They usually have no previous research experience and can bring only superficial epistemological insights to bear in these inquiries.

   We have developed several research simulations that elevate the preparation of most of our freshman students to participate successfully in this demanding program. These environments will be illustrated with our "Developmental Selection" research simulation. It includes three major modules. The first component allows students to alter system parameters with sliders, which allows them to develop their understanding of the foundational information required to study this phenomenon. The two remaining parts of the system focus the students experience on the differences between the initial "data collection" phase of the research experience and the "data analysis" phase of the investigation. Students often confuse these two processes.

   Assessment in this open-ended learning experience assumes a new form. As students move from the simulation to experimental design with real field samples in mind, real life issues like sample sizes and subtleties of the data scoring of complicated phenomena come into focus. Rather than relying on faculty authority to answer these questions, students are encouraged to return to the simulations to probe specific issues themselves. They learn the value of models to test our assumptions and to evaluate complicated phenomena in relative painless ways.

   Before the development of these research simulations, only our best students excelled in this experience. Many of our students seemed lost and revealed only limited learning outcomes from the experience. Introduction of these simulation prefaces has again evened the playing field for students with different levels of preparation for the experience (Figure 4).

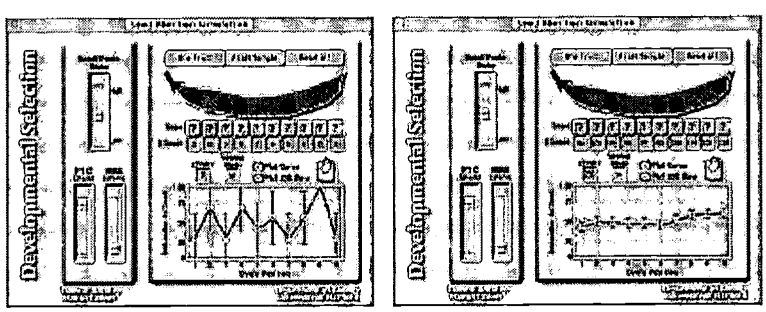

Figure 4. *Developmental Selection*: A simulation to foster student-originated research.

To summarize, the development of interactive multimedia learning environments by our faculty has allowed our faculty to teach things that we found difficult to teach before and we have been able to produce improved leaning outcomes for other content that was pedagogically challenging. Moreover, authoring interactive multimedia learning environments has allowed faculty to explore important principles of the learning paradigm that seemed much more daunting with traditional instructional methods. This technology has fostered the advancement of active-learning pedagogies in our teaching. It has improved our ability to exploit new insights about the cognitive development of learning. The utility of the computer to monitor student progress has encouraged us to think more carefully about assessment and to strive for the development of assessment tools that allow us to give our students more individual attention. Our authoring experiences have forced us to think more carefully about the appropriateness of different kinds of assessment tools for different kinds of learning experiences, especially new views of assessment that might better support open-ended learning experiences and active learning environments. Collectively, these features have allowed us to serve the varied learning styles of our students more carefully.

Citations

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