WHAT'S AHEAD FOR STEM AT UVA
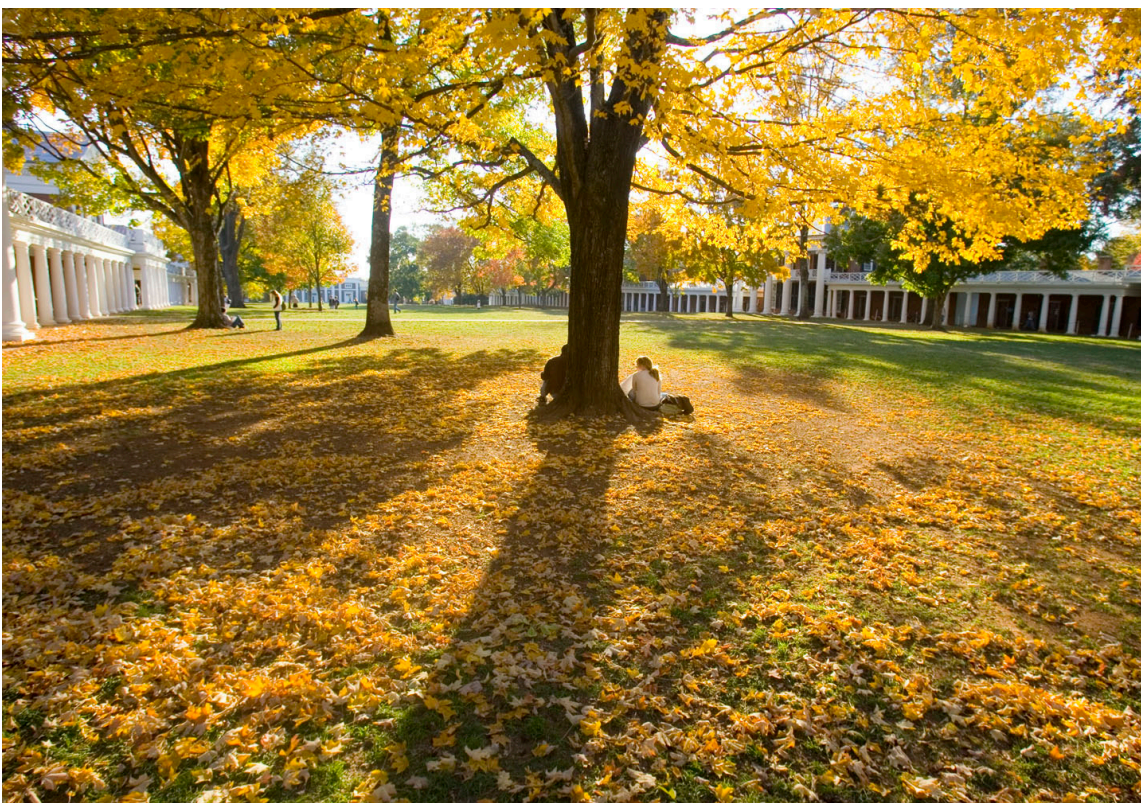
TRENDS AND BEST PRACTICES IN CURRICULUM INNOVATION, COLLABORATION, AND FACITIES DESIGN

LEARNING SPACES COLLABORATORY RFD T S O I / K O B U S & A S S O C I A T E S UNIVERSITY of VIRGINIA

Workshop Participants:

INTRODUCTION

As part of a larger planning effort which will focus on enrollment growth in the STEM disciplines, The University of Virginia (UVA) engaged Tsoi/Kobus and Associates, Inc. in collaboration with RFD and Jeanne Narum to conduct a workshop based on emerging trends and best practices in curriculum innovation, collaboration, and facilities design.

The University of Virginia is currently in a period of enrollment growth that expects to add over 1600 new students to the UVA Grounds. The initial years of this growth period indicate a significant increase in science and engineering majors, and increased workload for science instruction laboratories. The typical pressures of enrollment growth on University resources are exacerbated by an aging instructional and research infrastructure in the sciences, and changing pedagogical models fueled by technology and a new generation of learners. To meet this challenge, Arts & Sciences, SEAS, Office of the Provost, VP for Management and Budget, The Office of the Architect for the University, and Facilities Management are collaborating on a facilities plan for innovation and growth of STEM programs at UVA. The Curry School, and Nursing School are also participating in the study as key stakeholders in undergraduate STEM education.

The initial step in this planning process is to engage with faculty who are working on issues of pedagogy, curriculum planning and collaboration in the Schools: to enlist their support as advisors and contributors to the facilities plan, and to set general principles and goals for the planning process and its outcome. These guiding principles will inform the later stages of the study, when the emphasis will shift to identifying space planning alternatives, and capital development strategies.

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Aerial view along McCormick Road

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OVERALL STEM PLANNING STUDY SCHEDULE

Module 1 – Emerging Best Practices in Pedagogy and Teaching (March 28 & 29 2013)

Topic based Workshop with emphasis on new pedagogy

Support interdisciplinary study and collaboration among STEM course offerings

Module 2 – Supply Assessment (April – June 2013)

Evaluate buildings
Inventory of existing spaces

Module 3 – Demand Assessment (April – June 2013)

Explore flexibility of spaces and what types would fit within existing structures

Meet with faculty and review section sizes –vs- room sizes

Confirm enrollment growth and planning assessment demand

Module 4 – Synthesis (May – June 2013)

Create recommended strategies for optimum utilization

Test fits of the building program

Review effects of future enrollment growth

Module 5 – Setting a Direction (July – August 2013)

Recommend strategies for phasing work

WORKSHOP AGENDA

Thursday March 28

Zehmer Hall

8:00   Arrival, coffee

8:15   Welcome and introduction

Meredith Woo, Dean of the College and Graduate School of Arts & Sciences

Milton Adams, Senior Vice Provost

8:30   Focusing on 21st century STEM learner: Visions of what they are to become

Facilitator: Jeanne Narum

10:20   Break

10:30   Focusing on 21st century curricular and pedagogical approaches

Facilitator: Jeanne Narum

12:00   Informal conversation among faculty groups on topic responses (lunch provided)

1:00   At-the-table discussion & reporting out: where we may be headed at UVA

Facilitators: Jeanne Narum, Rick Heinz, Rick Kobus

1:50   Break

2:00   Focusing on STEM spaces for the future at UVA that serve STEM learners in different settings, at different stages in their undergraduate career

Facilitators: Jeanne Narum, Rick Heinz, Rick Kobus

3:30   Q&A, and wrap up

4:00   Finish

Friday March 29

Nau Auditorium, South Lawn Commons

12:30   Keynote Presentation: What's ahead for STEM at UVA: Rick Heinz, Jeanne Narum, Rick Kobus, UVA Colleagues

2:30   Q&A, and wrap up

3:00   Finish

WORKSHOP GOALS

GOALS

A shared language for STEM learning
and research at UVA

A common vision for STEM learning and
research at UVA

Collective ownership of the process of
planning and assessing learning spaces
at UVA

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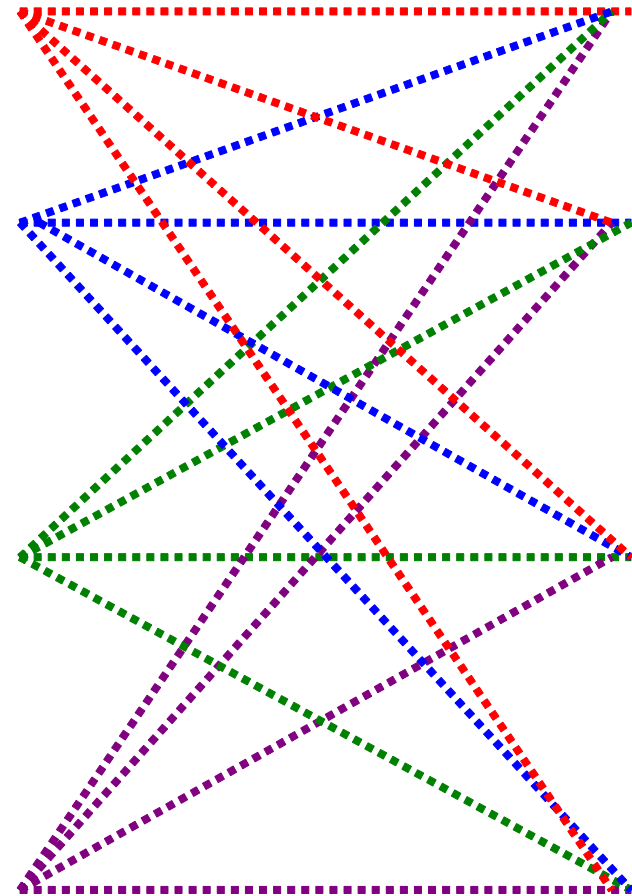
DOTS TO CONNECT

National calls to action

Expectations—societal
and from STEM
communities of practice

Research from the field of
learning sciences

Research and
evidence from the field
re: programmatic &
pedagogical change
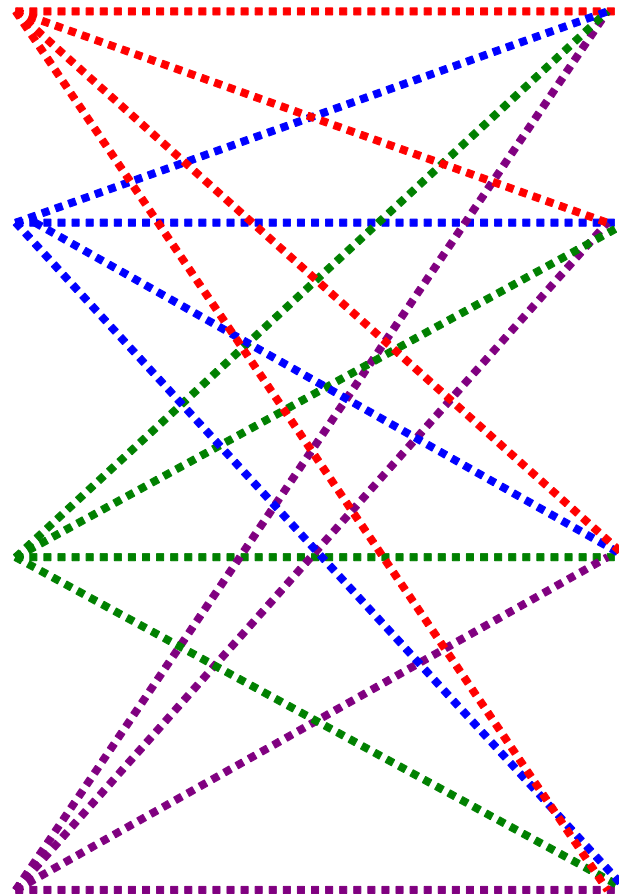
Spaces for active cognitive
challenges

Spaces for learning
in context, personally
meaningful

Spaces for reflective and
social learning

Spaces for constructing
one's own learning

QUESTIONS TO ASK

Identity and mission of the University of Virginia, now and into the future

Expectations for student learning at UVA, now and into the future

Expectations for STEM learning and research, now and into the future

Successes to build on, failures to learn from, now and into the future
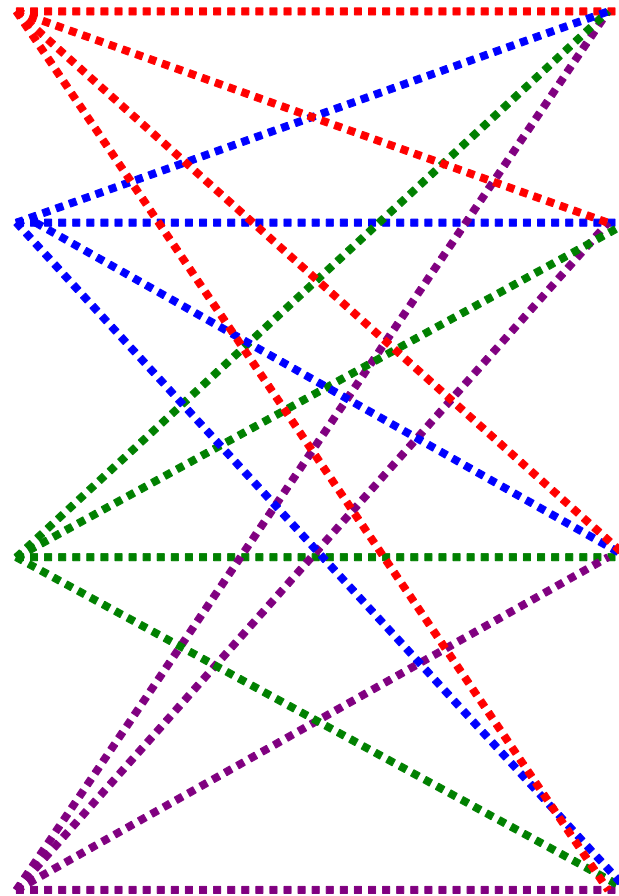
What we want our students to become, now and into the future

What kind of experiences enable that becoming, now and into the future

What kind of spaces enable those experiences, now and into the future

What kind of evidence will document that spaces make a difference, now and into the future

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NARRATIVE

Spaces for learning matter because they become:

Spaces in which humans grow; a learning community where mind and sensibility are shared…a place to learn together about the real world, and about possible worlds of the imagination…and to learn about the power of doing these things together.

— Jerome S. Bruner. Toward a Theory of Instruction. Harvard University Press. 1996.

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Attention to spaces for learning matters because:

We live in tumultuous times…the way forward is to become more open, more experimental and to embrace the unknown. We cannot turn inward, nor can we allow our institutions to become overly centralized, calcified and risk-averse. If America were a company, freedom and exploration would be our core competencies.

— Council on Competitiveness. National Innovation Initiative Summit and Report: Thriving in a World of Challenge and Change. 2005.

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Spaces that work are those that become an environment that is pleasant to be in, that can be explored and experienced with all the senses and inspires further advancement in learning.

The objective is thus to construct and organise spaces that enable children [learners]:

• To express their potential, abilities and curiosity;

• To explore and research alone and with others, both peers and adults;

• To perceive themselves as constructors of projects and of the overall educational   project…;

• To work and communicate with others;

• To know their identities and privacy are respected.

— Rinaldi, Carlina. In Dialogue with Reggio Emilia: Listening, Researching and Learning. Routledge. 2005.

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The effective STEM teacher must:

• … Motivate the student to put in the extensive effort that is required for learning. This involves generating a sense of self-efficacy and ownership of the learning; making the subject interesting, relevant, and inspiring; developing a sense of identity as a STEM expert; and other factors that affect motivation. How to do this in practice is dependent on the subject matter and the characteristics of the learner—their prior experience, level of mastery, and individual and sociocultural values.

• … Understand how learning works ….

— Wieman, Carl. "Applying New Research to Improve Science Education." Issues in Science and Technology. Volume XXIX Number 1. Fall 2012.

Research on how people learn offers design professionals and academic leaders intriguing opportunities for shaping and reshaping undergraduate learning environments for 21st century learners. Within and beyond STEM fields, faculty and their administrative colleagues on campuses across the country are making research-based decisions about what their students should learn and about how that learning is to happen.

From the work of these pioneering agents of programmatic and pedagogical change, there is a substantial body of evidence validating that learning is most robust as students begin to realize the powerful role they play in their own learning and become responsible for constructing their learning. This evidence validates findings that deep learning happens as learners become socialized into a community of learners on-campus and develop a sense of identity with a community of practice beyond campus.

The Learning Spaces Collaboratory (LSC) is based on the premise that robust learning happens as students are:

• Actively engaged in evaluating, constructing, and reevaluating their own knowledge

• Actively engaged in a social and supportive community

• Encouraged to assess, reflect, and build on prior knowledge

• Empowered to address problems that are meaningful personally and of import to the world beyond the campus.

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We recognize that as robust learning empowers learners, students are becoming agents of their own learning. They are becoming adventurous, tolerant of ambiguity, eager to ask new questions; they are testing the boundaries and limits of what is known, not known. Thus, robust learning happens when it is:

• Iterative and non-linear

• Provisional, always in a state of flux, of becoming

• Scaffolded and transferable

• In turn, social and solitary

• Understood by all—student and teacher—as preparation for what comes next.

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On an individual campus, questions such as the following must be asked by those involved with teams charged with responsibility for the physical environment for learning:

• Is what is known about how learning happens from research, and from findings from the work of change agents in other settings, influencing how learning happens on our campus? If so, how and where?

• How might such research and findings about how learning happens, within and beyond our campus, help us fulfill our responsibilities as planners more creatively, efficiently, and cost-effectively?

• How do 21st century mental images of how learning happens differ from those held by previous generations of planners? How do mental images about learning influence our planning?

• Beyond these findings on how learning happens, what other contextual issues must be identified and addressed in giving attention to spaces for learning on our campus, now and into the future?

Answers to the final question are threaded through contemporary reports from a diverse range of stakeholder groups, including the Council on Competitiveness, Association of American Colleges and Universities (AAC&U), National Science Foundation, and from STEM communities of practitioners. Among the more provocative reports are those from the President's Council of Advisors on Science and Technology (PCAST) and from the National Research Council (NRC):

• Discipline Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering.

• A New Biology for the 21st Century

• The Engineer of 2020: Visions of Engineering in the New Century

• Expanding Underrepresented Minority Participation.

• Engage to Excel: Producing One Million Additional College Graduates with Degrees in STEM.

Although prepared by and for STEM communities of learners and practitioners, the messages of these reports are clear. First, given the urgent challenges facing our nation, global community, and planet, 21st century learners in all fields of study must be empowered to address problems that are meaningful personally and of import to the world beyond the campus. Second, empowering 21st century learners must be accepted as a communal responsibility rather than that of a lone ranger agent of change.

Although sparked by a different contextual reality, there is a marked, but not surprising, coherence in their vision of what 21st century learners are to become and of goals and strategies by which that vision can be realized. However, none makes explicit reference to the reality that as attention is given to transforming the undergraduate learning environment, where learning happens is as critical as attention to how learning happens. This is puzzling, given evidence from a growing number of campuses about how transformed spaces contributed to transformed learning. That said, these reports must not be dismissed. They can be taken, and must be taken, as road maps for the journey into and through the planning of 21st century learning spaces for 21st century learners. This is a journey of wrestling with the ill-defined question about how space matters to learning.

FIVE REPORTS

Discipline Based Education Research (DBER)

A New Biology for the 21st Century

The Engineer of 2020

Expanding Underrepresented Minority Participation

Engage to Excel

I. Summary of DBER report (Discipline-Based Education Research)

Recognizing the emerging and significant body of education research, validated across disciplinary communities about how to engage, inspire, and motivate 21st century learners in STEM fields, the DBER working group set out to investigate learning and teaching in a discipline, using a range of methods with deep grounding in the discipline's priorities, worldview, knowledge, and practices. It is informed by and complementary to more general research on human learning and cognition. Those engaged in discipline-based education research over the past twenty years recognized the timeliness of moving from discussions within individual disciplinary fields and loosely connected, informal discussions across disciplinary boundaries into a formal working group to share findings, identify commonalities and gaps in their research, and explore questions for future efforts.

One value of the DBER report as a starting point in this context is that it illustrates the power of boundary-crossings between communities of practice, of the impact of working toward a shared language, a deeper understanding of questions to pursue, and a common vision of what they wish to accomplish.

Another reason for beginning with DBER is that it introduces the 'problem-solving' theme woven explicitly or implicitly through each of these reports. In examining how learners come to understand the nature of a discipline and begin to develop expertise in a discipline, DBER authors highlight 'problem solving,' identified as…the most quintessential expression of human thinking.

It is required whenever there is a goal to reach and attainment of that goal is not possible either by direct action or by retrieving a sequence of previously learned steps from memory. That is, during problem solving the path to the intended goal is uncertain.

Although addressing the nature of problem solving from different STEM disciplinary perspectives, one DBER goal was to improve science and

engineering instruction for all students… to identify approaches to make science and engineering education broad and inclusive.

Society's most important problems are usually ill-defined in some way. These are the kinds of problems students will have to solve after they graduate. Students who have scant experience with ill-defined problems during their undergraduate education may be poorly prepared to grapple with the most significant problems in their fields.

The significance of the DBER report for planners goes beyond its focus on problem solving, its goal of improving STEM learning for all students—not only self-identified majors.

It presents one of the 21st century realities that must be recognized by planners of spaces: the depth and breadth of documented evidence across disciplinary fields, from campuses of different sizes, missions, and circumstances that research-based approaches enhance student motivation, persistence, and achievement. No longer can an argument for the status quo be based on the claim that there is not yet sufficient evidence of the efficacy of such approaches.

The DBER report is an invitation to a wider community of stakeholders to investigate and document how learning happens. This is an opportunity for investigating and documenting how space matters to learning, putting forth a new set of questions to be addressed at both the institutional and national level in the pursuit of a vision of robust learning in STEM fields.

DISCIPLINE-BASED EDUCATION RESEARCH
Understanding and Improving Learning in Undergraduate Science and Engineering

NATIONAL RESEARCH COUNCIL
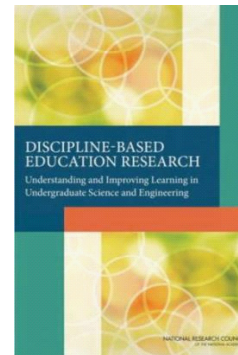
Problem-solving may be the quintessential expression of human thinking.

For an engineering problem, the goal may be ill-defined…

Society's most important problems are usually ill-defined in some way.
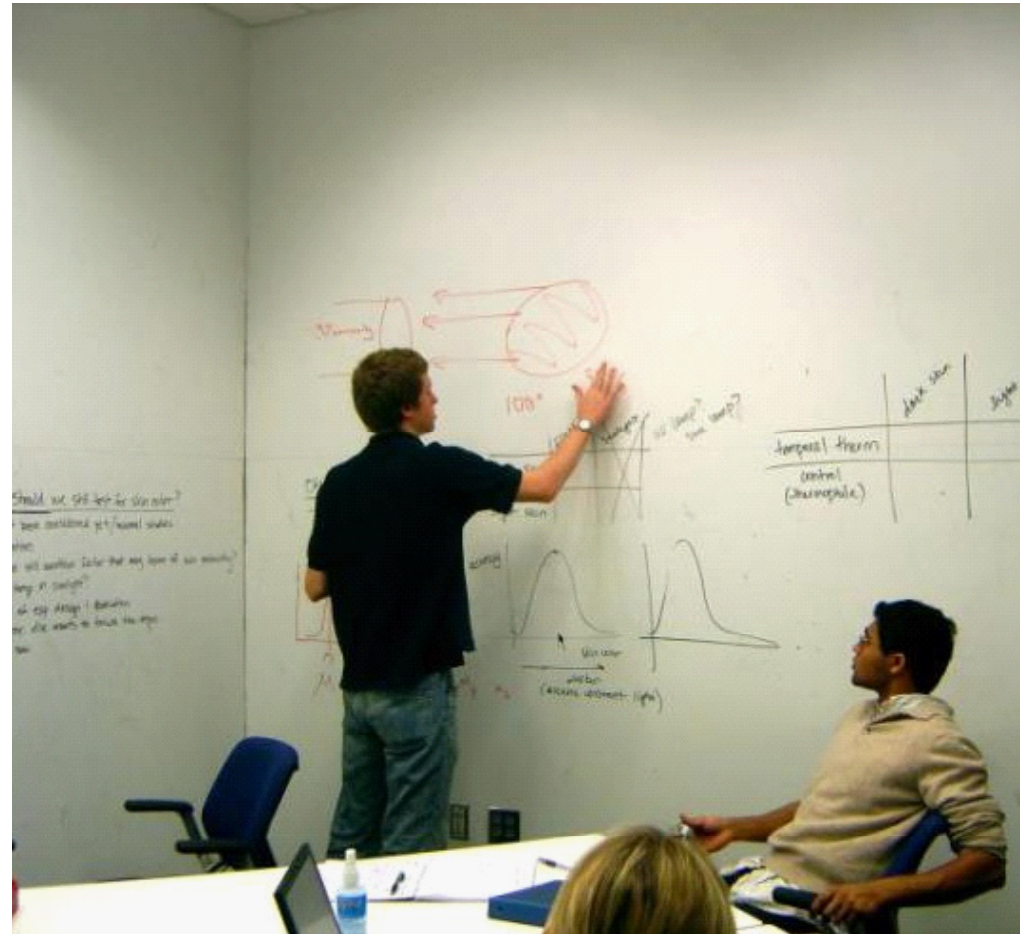
II. Summary of A New Biology for the 21st Century

Also from the NRC, the A New Biology for the 21st Century report presents a broader context for nurturing 21st century problem solvers, anticipating a future world they might shape, a world:

- where there is abundant, healthful food for everyone
- where the environment is resilient and flourishing
- where there is sustainable, clean energy
- where good health is the norm.

Each of these goals is a daunting challenge. Furthermore, none can be attained independently of the others—we want to grow more food without using more energy or harming natural environments, and we want new sources of energy that do not contribute to global warming or have adverse health effects. The problems raised by these fundamental biological and environmental questions are interdependent and 'solutions' that work at cross purposes will not in fact be solutions.

The case made in A New Biology important for planners is that society is at a tipping point in terms of challenges that influence our collective long-term future. The reality that solutions to 21st century problems are beyond the scope of a single discipline or area of research practice cannot be avoided by those responsible, in the 21st century, for learning spaces in the undergraduate setting.

As noted in Facilitating Interdisciplinary Research, another influential report from the National Academies:

…four powerful 'drivers' [of interdisciplinary thinking are] the inherent complexity of nature and society, the desire to explore problems and questions that are not confined to a single discipline, the need to solve societal problems, and the power of new technologies.

Authors of A New Biology report suggest that at its essence the new biology is integration—the re-integration of the many sub-disciplines of biology, and the integration into biology of physicists, chemists, computer scientists, engineers, and mathematicians to create a research community with the

capacity to tackle a broad range of scientific and societal problems…

Purposefully organized around problem-solving, this approach marshals the based research to advance fundamental understanding, brings together researchers with different expertise, develops the technologies required for the task and coordinates efforts to ensure that gaps are filled, problems solved, and resources brought to bear at the right time. Combining the strengths of different communities does not necessarily mean bringing these experts into the same facility to work on one large project—indeed, advanced communication and informatics infrastructures make it easier than ever to assemble virtual collaborations at different scales.

As with each of these reports, A New Biology imagines a future for research in STEM fields that challenges the present of STEM learning, recognizing that students will have to be educated in new ways…. Its approach suggests the power of imagining a future, of backward engineering the process of undertaking transformative initiatives.
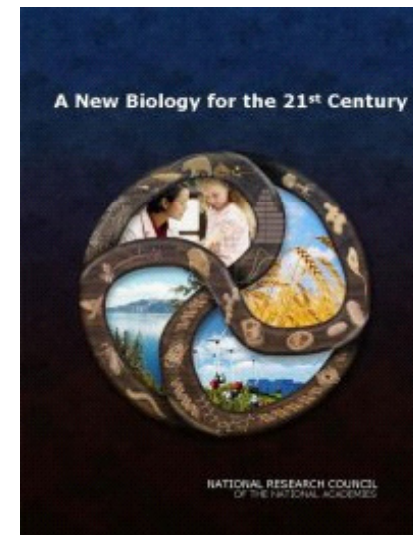
Purposefully organized around problem-solving, this (New Biology) approach marshals the basic research to advance fundamental understanding, brings together researchers with different expertise, develops the technologies required for the task and coordinates efforts to ensure gaps are filled, problems solved, and resources brought to bear at the right time.

If we want UVA students and alums to be recognized for

- their capacity and creativity as hybrid thinkers

- for their openness to new experiences

- their ability to synthesize theory and practice from diverse fields in addressing complex societal challenges

What questions do we ask in exploring what's ahead for STEM at UVA?

III. Summary of The Engineer of 2020: Visions of Engineering in the New Century

As with A New Biology, the case made in this report for transforming learning within a particular STEM community of practice is based on analyses of current trends that anticipate a future quite different from the present. They identified these guiding principles that will shape engineering activities:

• The pace of technological innovation will continue to be rapid (most likely accelerating).

• The world in which technology will be deployed will be intensely globally interconnected.

• The population of individuals who are involved with or affected by technology…will be increasingly diverse and multidisciplinary.

• Social, cultural, political, and economic forces will continue to shape and affect the success of technological innovation.

That excerpt helps to inform (or remind) planners that all disciplinary communities recognize such trends and are coming to grips with how they influence efforts to shape and reshape undergraduate STEM learning environments. This report illustrates the importance of taking time to connect the dots between carefully crafted and examined scenarios of the future and the preparation of engineers for the future. This underscores the importance of cross-cutting conversations in which colleagues from various STEM communities and their administrative colleague wrestle with the implications of these trends in the planning of spaces for the future.

Among the reports in this set of reports, the Engineer of 2020 presents the clearest image of what it is to be a practitioner in the field. The elegantly defined attributes of the engineer of the future can be taken as attributes of what the learner should be and become as a result of his or her learning experiences in all STEM fields. In addition to the important attributes of possessing strong analytical skills, the ability to listen effectively as well as to communicate through oral, visual, and written mechanisms, and become lifelong learners, they define a set of attributes that:

…cannot be described in a single word. It involves dynamism, agility,

resilience and flexibility. Not only will technology change quickly, the social-political-economic world in which engineers work will change continuously. In this context it will not be this or that particular knowledge that engineers will need but rather the ability to learn new things quickly and the ability to apply knowledge to new problems and new contexts.

Aspirational attributes for all students in 21st century STEM learning spaces. The challenge for planners is to arrive at language that goes beyond the familiar able to work in teams to language that is more evocative of what the learners are to become and thus what the spaces are to become. Perhaps dynamic, agile, resilient, and flexible are appropriate attributes of 21st century learning spaces as well as of 21st century learners.
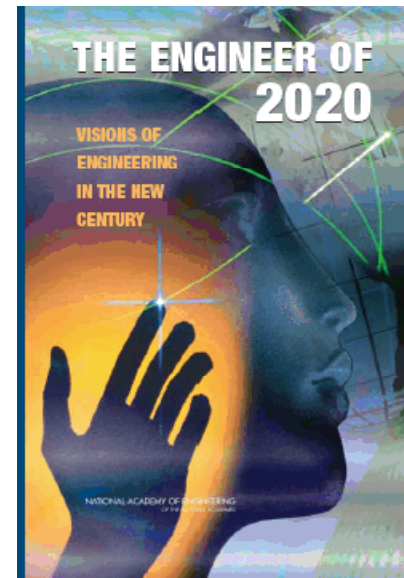
Creativity….is an indispensable quality for engineering, and given the growing scope of the challenges ahead and the complexity and diversity of the technologies of the 21st century, creativity will grow in importance. The creativity requisite for engineering will change only in the sense that the problems to be solved may require synthesis of a broader range of interdisciplinary knowledge and a greater focus on systemic constructs and outcomes.

IV. Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads.

This provocative report presents the challenge of transforming the STEM learning environment as a societal challenge to be addressed at the institutional level. The context is clear by the title: signaling the need to ensure the persistence and success of all STEM learners in a time of significant demographic changes, a time when no talent should be lost in the service of the nation, noting that those groups that are most underrepresented in S&E are also the fastest growing in the general population.

It is recognized by all that students moving in and through our nation's classrooms, labs, and other learning spaces today are increasingly diverse, coming with differing preparations and expectations for their undergraduate years and career aspirations for their future. This report calls for greater attention to the current success or lack of success of these students on one's home campus as well as across the higher education community. It highlights approaches that work for all students, including that of empowering the learner, emphasizing that motivation is a key ingredient for success.

Authors identify several dimensions of the learning environment to be examined for their influence on motivation and persistence, on developing that sense of identity, gain a sense of their own abilities:

•   The availability of inquiry-based learning or engineering design activities through which students use and create scientific and technical knowledge, learn how to generate evidence…and develop the sense of competence that is critical to identification with a field of endeavor such as STEM.

•   The design of introductory courses that weed out rather than encourage them to begin to see themselves within a STEM community of practice.

•   The opportunities for engaging in rich research activities that stimulate student interest in STEM fields and socialize them within a discipline.

•   The inclusion in a campus culture in which students feel socially and intellectually integrated.

At the most general level, the institutional commitment to inclusiveness and the policies used to express that commitment play a critical contextual role for programs designed to increase underrepresented minority participation in undergraduate and graduate STEM. Therefore, a campus-wide commitment to inclusiveness provides the best environment for planting the seeds of diversity.

The reality is that recognizing and celebrating diversity is an imperative for the nation's future, that the problem is urgent and will continue to be for the foreseeable future.

For the United States to maintain the global leadership and competitiveness in science and technology that are critical to achieving national goals today, we must invest in research, encourage innovation, and grow a strong, talented, and innovative science and technology workforce.
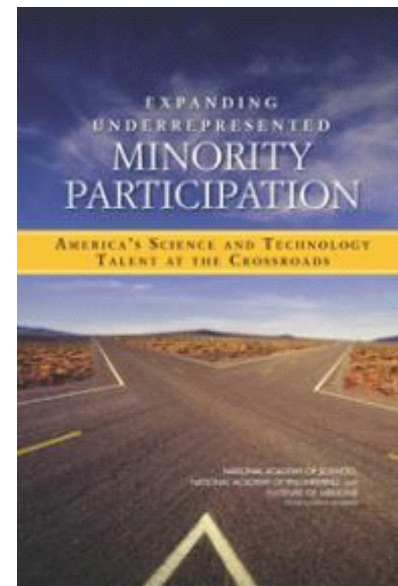
Proven, intensive interventions for underrepresented minorities in STEM include:

- Build learner communities

- Provide research experiences

- Provide professional development activities

- Provide academic support and peer and faculty/TA mentoring

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V. Report to the President: Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics. President's Council of Advisors on Science and Technology (PCAST). 2012.

This report presents very specific recommendations about actions to be taken at the institutional level, by faculty and campus leaders and by stakeholders at the national level. These recommendations are based on their analyses of what works and what doesn't work now, given current research understandings about how people learn. Among this small set of reports, Engage to Excel is the only one to give explicit attention to the process of change, alerting the community that the research on how change happens is as critical to the planning process as research on learning.
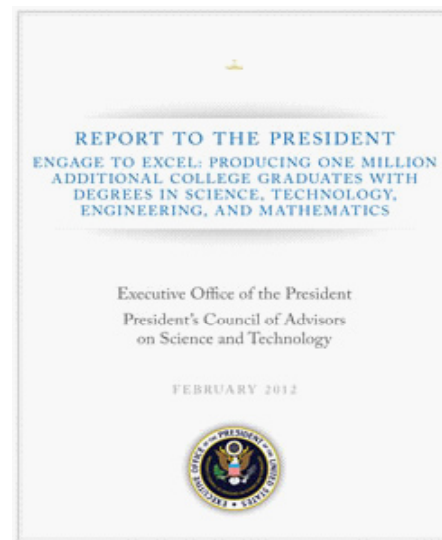
People are usually resistant to change. One reason that many faculty may maintain traditional teaching practices is that they have been successful in their fields and therefore assume that the educational approaches that taught them so effectively are appropriate for all students. But resistance to change is human and has been confronted successfully in numerous other settings. The study of individual, organizational, and cultural change is a sophisticated field that can inform the design of transformation strategies for STEM education in the first two years of college.

Given the current urgency (signaled by the title), their most pressing and feasible recommendation is that attention be given to the first two years of college at both the campus and the national level. Their case is made by contrasting two kinds of learning experiences for students at that level.

Traditional introductory laboratory courses generally do not capture the creativity of STEM disciplines. They often involve repeating classical experiments to reproduce known results, rather than engaging students in experiments with the possibility of true discovery. Students may infer from such courses that STEM fields involve repeating what is known to have worked in the past rather than exploring the unknown. Engineering curricula in the first two years have long made use of design courses that engage students creativity.

Recently, research courses in STEM subjects have been implemented at diverse institutions, including universities with large introductory course enrollments. These courses make individual ownership of projects and discovery feasible in a classroom setting, engaging students in authentic STEM experiences and enhancing learning and, therefore, they provide models for what should be more widely implemented.

This brief quote reflects the extensive collective of models for what should be more widely implemented presented in this report, with full documentation of or links to studies that demonstrate the effectiveness of research-based learning approaches. It is a compendium of transformational strategies for transforming undergraduate STEM learning environments.

REPORT TO THE PRESIDENT
ENGAGE TO EXCEL: PRODUCING ONE MILLION
ADDITIONAL COLLEGE GRADUATES WITH
DEGREES IN SCIENCE, TECHNOLOGY,
ENGINEERING, AND MATHEMATICS

Executive Office of the President
President's Council of Advisors
on Science and Technology

FEBRUARY 2012

The first two years of college are the most critical to retention and recruitment of STEM majors….

Research indicates that student persistence in a STEM degree is associated primarily with three aspects of their experience….

Compared with students in traditional lectures, students who play an active role in the pursuit of scientific knowledge learn more and develop more confidence.

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If we want UVA students to

- take ownership of their own learning

- to be motivated to persist and succeed from the very first day in STEM classrooms and labs

What questions do we ask in exploring what's ahead for STEM at UVA?

WORKSHOP OUTPUT

What we Heard

Discipline Based Education Research (DBER)

A New Biology for the 21st Century

The Engineer of 2020

Expanding Underrepresented Minority Participation

Engage to Excel

1. Discipline Based Education Research (DBER): How do we obtain resources for faculty and TA training, laboratory space, and advising for experiences that will attract and excite students?

2. A New Biology for the 21st Century: How do we reconstruct a 300+ classroom to integrate chemistry, physics, biology, etc.?

3. The Engineer of 2020: What is getting in the way of higher order (new learning)?

4. Expanding Underrepresented Minority Participation: How do we engage and excite our students? What practical models can we get from research to improve learning and excitement?

5. Engage to Excel: How do we instill problem-solving skills in a large population of STEM students? How do we give students the opportunity to fail and learn from those failures?

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How do we obtain resources for faculty and TA training, laboratory space, and advising for experiences that will attract and excite students?

- How do we learn what our students need, in order for them to become engaged?

- How do we engage students in hands-on science?

- Are TA's the appropriate means to aid learning?

- How do we train TA's (and faculty) to teach?

- How do we alert faculty to new instructional technology?

- How do we improve flexibility/multi-purpose capacity of labs/classrooms?

- How do we attract donor funding for what we need to do?

Do we need to construct a 300+ classroom to integrate chemistry, physics, biology, etc.?

- Does the 300+ classroom need to be a physical space?

- Do we need a classroom for 800 – 1000 students?

- At what levels are we considering integrating disciplines?

- How do we create space to engage faculty and students for higher order learning exercises?

- minded thinking and new solutions for new problems?

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What is getting in the way of higher order (new learning)?

- How do we de-program students from SOL (Va Standard of Learning) culture, and engage students to make meaning of their education?

- How do we prepare faculty to teach in new ways and modes?

- How does the institution have to change to reward and promote pedagogical innovation?

- How do we build a culture of assessment in all teaching experiences?

- How do we link innovations across the curriculum?

LEARNING SPACES COLLABORATORY   RFD   TSOI / KOBUS & ASSOCIATES   UNIVERSITY of VIRGINIA

How do we engage and excite our students? What practical models can we get from research to improve learning and excitement?

- How do we account for the disconnect between the background, motivation, learning styles of our faculty and that of our new learners?

- How do we assess entry level students and evaluate their skill level?

- How do we "on-board" learning skills to allow students to succeed?

How do we instill problem-solving skills in a large population of STEM students? How do we give students the opportunity to fail and learn from those failures?

- How do we provide learning skills to allow students to succeed?

- How do we instill problem-solving skills in a large population of STEM students?

- How do we give students the opportunity to fail and learn from those failures?

- How can inquiry-based problem-solving methods be scaled up to large class sizes?

- If we use student mentors to scale group learning to large classrooms, how do we maintain quality control? How do we reward mentors (course credit, stipend)?

- How do we alter student's motivation from "earning a high grade" to learning from the excitement of discovery?

- How do we create spaces that help faculty to activate and engage students for higher order learning exercises?

- How can spaces empower faculty to encourage open-minded thinking and new solutions for new problems?

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Student experience should engender:

- Passion

- Motivation

- Interest

- Student-to-student interaction

- Exposure to diversity of thought

- Peer mentorship opportunities

- Group problem solving

- Exposure to "BIG DATA"

First-year Undeclared Major

- Discover in lab, not cookbook

- Part of community

- Role modeling by upper class facilitators

- Change assessment methods

- Peer grades, writing grades, no grades?

- Sense of accomplishment each session: product

- Experience of full breadth of discipline

4th Year Declared Major

- Comprehensive skill set

- Experience with research

- Experience with study in depth

- Opportunity to mentor other students

- Mentoring by alumni

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