Integrating Evidence: The STIRS Approach
“Facts are stubborn things; and whatever may be our wishes, our inclinations, or the dictates of our passion, they cannot alter the state of facts and evidence.”

—John Adams

During the recent US election cycle, many voters read several print and online articles, watched televised interviews and debates, and attended political events in order to learn about candidates’ positions. The abilities to interpret facts, weigh evidence, and think critically about the information garnered through these sources are necessary skills that allow us to make our best choices. Without these competencies, one can default to making important decisions by using what late-night television host Stephen Colbert calls “truthiness”—defined by dictionary.com as “the quality of seeming to be true according to one’s intuition, opinion, or perception without regard to logic, factual evidence.” With important matters at stake such as determining local and national elected officials, it is essential that today’s college students graduate with highly developed evidence-based reasoning skills.

To support the goal of ensuring that all students develop evidence-based reasoning skills throughout their college careers, AAC&U launched its Scientific Thinking and Integrative Reasoning Skills (STIRS) project in 2012. In the Spring 2012 issue of Liberal Education, Richard Riegelman wrote, “Evidence-based problem solving represents an integrative approach to the application of scientific principles across the natural, behavioral, and social sciences…. Evidence-based problem solving can be an especially effective method for achieving the fourth LEAP Essential Learning Outcome: integrative and applied learning.”

The STIRS project has unfolded in several stages. First, dissemination of the STIRS framework, the project’s guiding principles, helped launch a national dialogue about models that integrate evidence-based thinking across general education and in the major. In 2014, thirteen STIRS Scholars were selected to create real-world, peer-reviewed case studies that would illustrate one or more of the original STIRS framework components. The STIRS case studies, which are available at no cost on the AAC&U website (https://www.aacu.org/stirs/casestudies), have been downloaded by several institutions of various types from across the country. In the most recent STIRS phase, five STIRS Fellows were selected to work with their institutions to incorporate the STIRS framework into thematic, scaffolded, four-year curricula that will culminate in capstones or signature work. As part of this work, the STIRS Fellows intend to develop a tool, using the VALUE rubrics, that will help educators assess student learning relative to evidence-based reasoning.

This issue of Peer Review features articles examining the many aspects of the STIRS project through a variety of lenses. AAC&U President Lynn Pasquerella frames the issue by considering the necessity of evidenced-based problem-solving skills from both AAC&U and first-hand perspectives. Richard Riegelman offers a project overview, with particular attention to the STIRS framework and the competencies it outlines. Also included is an article written by several of the STIRS Scholars that describes the process by which the STIRS case studies were developed and another that discusses case study use. A piece written by the STIRS Fellows details the goals and implementation of the STIRS project’s institutionally based work. Finally, Terrel Rhodes’s Reality Check closes the issue with a meditation on encouraging higher education faculty and administrators to create the time for reflection as they build upon old and create new educational practices.

Rhodes’s call for educators to reflect—to slow down and to critically evaluate the options—is also wise counsel for students in a time when they are constantly being bombarded with news through traditional and social media. The need for students to develop the capacities promoted by the STIRS project—the abilities to use evidence effectively in problem solving and decision making—is key not only to their academic successes but also for all of our futures in a complex and volatile world.

—SHELLEY JOHNSON CAREY
Scientism, Human Consciousness, and the STIRS Imperative

Lynn Pasquerella, president, AAC&U

From its inception in 2012, the Scientific Thinking and Integrative Reasoning Skills (STIRS) project has served as a call to action for faculty to develop and implement curricula in every discipline that will prepare students to address the most pressing global and local challenges of the day. The integrative learning framework upon which STIRS was founded recognizes the critical importance of cross-disciplinary thinking; the need to interrogate what constitutes evidence in proposing and constructing evidence-based solutions; and the imperative that decision making be grounded in the ethical principles of respect for persons, justice, and beneficence.

A MORE COMPREHENSIVE APPROACH TO EXAMINING SCIENTIFIC INQUIRY

As someone whose teaching and research career has focused on applied ethics in medicine, law, and public policy, I am reminded daily of the ways in which technological advancements often precede thoughtful reflection regarding the ethical, legal, and social implications of the use of that technology. This is one of the many reasons why I welcomed the broadening of the Medical College Admission Test to include a more comprehensive approach to examining scientific inquiry within the context of behavioral and social sciences and the humanities, along with the development of STIRS to aid in student preparation.

In an age of electronic medical records, the ability to apply theories, methods, and skills in analyzing complex problems and make connections among concepts and experiences is more important than ever. Far from a panacea, the proliferation of data available to clinicians makes it impossible to keep pace. The availability of vast amounts of emerging information within data warehouses is meaningless in the absence of a physician’s capacity to collate data sources or interpret the results. Fortunately, there are experts in various specialties who can be relied on to synthesize research findings. Nevertheless, the clinician is still required to have the ability to make sense of that data and evaluate its reliability in a manner that serves the needs of individual patients.

For instance, if a physician is considering a drug for a patient that carries a 5 percent risk of internal bleeding over a five-year period and reads a study indicating that an alternative drug reduces that risk by 40 percent, she needs to be able to determine whether the reduction of a bleeding risk to 2 percent over that same period is worth tripling the cost for the patient. In addition, if the drug carries a greater risk of heart attack in patients with a history of heart disease, the physician will need to spend time with the patient discerning and weighing that particular risk in relation to others.

The complexities don’t stop there. A patient’s team of physicians might include an oncologist, surgeon, pulmonologist, cardiologist, palliative care specialist, hospitalist, and family practitioner, some of whom may arrive at different and conflicting conclusions about the best course of action for treatment. Under such circumstances, the patient becomes the nexus for decision making. In the past, family practitioners were the most likely to have the fullest understanding of whether a given medical decision was authentic—consistent with the way the patient has lived her life—after engaging in a values inventory over a period of years. Yet, in the case of hospitalized patients, a hospitalist may replace the family practitioner, and the system of Relative Value Units used in the United States to determine reimbursement for physician services has placed pressure on physicians to see more patients for shorter amounts of time, posing a challenge for the type of comprehensive information gathering necessary to act in the best interest of the patient.

Developing the type of deeper-level understanding across subject areas promoted by STIRS, connecting knowledge to expe-
perience, and adopting a holistic approach to evidence-based problem solving that incorporates diverse, sometimes contradictory points of view, is more important than ever—not only in preparing medical students, but for all undergraduate and graduate students to address the twenty-first century’s unscripted problems. Employers, educators, and professional accreditors alike are advocating integrative, evidence-based learning as essential preparation for student success upon graduation. For instance, the Accreditation Board for Engineering and Technology (ABET) advances an integrative approach to engineering education, with students working in multidisciplinary teams to apply their knowledge and skills in real-world contexts.

A FIRST-HAND OBSERVATION OF INCORPORATING THE STIRS APPROACH

I had the opportunity to observe firsthand the benefits of incorporating the STIRS approach into an engineering curriculum when I was leading an inter-institutional, multidisciplinary vertical research team to facilitate clean water solutions, sustainable agriculture, and entrepreneurship for residents in Kenya’s West Lake District near Lake Victoria from 2008–2012. The communities we collaborated with had a 33 percent HIV rate, a 69 percent poverty index, and an 80 percent rate of polygamy. The practice of widow inheritance, in which a woman is expected to have unprotected sex with a male relative of her husband upon his death, was still prevalent. In addition, the symptoms of AIDS were regarded by many community members as not resulting from a virus, but rather the effects of violating cultural taboos, including a refusal to be inherited.

The Centers for Disease Control Kenya joined a number of government agencies and nonprofit organizations to provide medication and social services to those who tested HIV-positive. Yet, many of the residents were dying from AIDS-related illnesses, dysentery, and diarrhea that were caused by a lack of access to clean water. Though the US Agency for International Development (USAID) had constructed a well for residents in one of the villages a few years earlier, when a piece of the pump broke there was no mechanism to fix the problem. To avoid this type of obstacle to sustainability in the future, the objective of our team was to engage in community action planning with residents to develop simple engineering solutions, such as clay pot water filtration, sand filtration, and Moringa seeds as natural flocculants, to provide clean water using local materials.

Partnering with students and professors at Kenyan universities, together with the community members themselves, we appealed to local epistemologies in order to identify the best way to harvest sand from local riverbeds without machinery and to create grass kilns, which at times turned out to be more effective than those designed in our engineering labs. While the ultra-affordable engineering solutions were developed rapidly, their implementation was often challenged due to the behavior change necessary for residents to take advantage of the technology in a manner that was effective in preventing disease. For example, while clay pot water filtration with a coating of colloidal silver on the rim was the most effective, the process of purifying water this way took longer, which led to resistance. While less efficacious, Moringa seeds provided some beneficial filtration, but the trees were regularly harvested by residents for fuel. In order to identify the best solution for each community, the psychologists, sociologists, and Africana studies team members undertook extensive qualitative research using interviews to determine any psychosocial, environmental, or economic barriers to success and the optimal means of overcoming them.

Yet, beyond addressing the psychosocial issues, scaling up with regard to whatever sustainable local solution was decided upon required communicating effective techniques to a broad population, most of whom were illiterate. Since women and girls were the ones gathering and distributing the water, students and faculty from the engineering, hydrology, and environmental economics departments worked with our artists and graphic designers to engage community members in creating visual messages that could be printed on kanga cloths—the traditional dress of women in the region—and disseminated widely. Throughout the project, every member of the team was involved in cross-disciplinary, collaborative, problem-based, integrative, evidence-based learning.

Moreover, the project was designed so that the benefits extended to those who could not be with us in the field. Subsequent sets of problems identified by the community through action planning, invariably involving additional layers of complexity, were brought back to the classroom in each discipline for a semester- or year-long problem-based learning project. Thus, at one institution, clay samples were brought back from a particular region for students in a civil and environmental engineering class to analyze in relation to the appropriate mixture of clay and sawdust to recommend for the construction of filtration pots. Business students from another institution were assigned to work on a business plan for securing microloans to support entrepreneurship around the production and marketing of kanga cloths. And at another university, medical students focused on research regarding the most successful techniques for serving non-adherent, at-risk populations of patients and developing the cultural competence necessary to be effective.
Taking up Frank’s charge to consider how scientism manifests itself, and in particular how the metaphysics of consciousness offers the tools necessary for building the space to which he refers, we need to ask, “What would we lose, if anything, by reducing all learning and engagement to practices only rooted in the sciences?” In response, and with STIRS in mind, what needs to be contrasted is not science and the humanities, arts, and social sciences, but rather scientism as a competing ideology to a liberal arts sensibility that we bring to all disciplines, including the sciences. This fact is highlighted by philosopher Mark Kingwell (2013) in his Harper’s article, “Beyond the Book,” which focuses on the future of the book—given the burgeoning of technology—and more importantly, on the future of reading as a matter of human consciousness.

Kingwell points to the rise of the educated reading public as inextricably linked to the emergence of democratic liberalism in the Western world (15). Likewise, he highlights the development of the novel as conjoined with the idea of open public discourse and rational/critical debate. Yet, most compelling is Kingwell’s unpacking of Marshall McLuhan’s contention that the printing press spawned, among other phenomena, “a psychological mode of introspection or inner direction” that attends reading. Through literature, readers are able to “substitute the consciousness of a (fictitious) other person for their own. This doubling and suspension of consciousness is, paradoxically, essential to enriching one’s own sense of interiority or inwardness. Reading offers a heady way of identifying with another, mirroring and reinforcing the self” (Kingwell 16).

For Kingwell, reading “objectively summons a subjectivity that belongs to each one of us,” making printed books and the democratized culture of reading, in his view, the most significant development in human consciousness since the advent of writing (Kingwell 17). Individual human consciousness will dictate the presence of what he refers to as “long-form reading,” according to Kingwell, not because books make us better people but because they “give...respite from the incessant noise of existence” (Kingwell 19). He maintains that this type of humanistic engagement provides a necessary, even if illusory, hypothetical narrative of the self.

What we lose by replacing humanism with scientism, then, is a long-form engagement with the world. The practice of science is, by its very nature, a short-form practice. It is an evidence gathering exercise dependent upon the banking of empirical data. To be sure, this type of practice positively influences our lives in a multiplicity of ways. And, it is what we rely on in times of medical crises, when we, or a loved one, are diagnosed with a life-threatening disease. On the other hand, questions about difficult situations such as “How should I live my life now that I have cancer?” or “Should a loved one accept a particular treatment that will extend life at the cost of quality during his or her remaining months?” are philosophical matters that cannot be resolved by data gathering. They require long-form contemplation.

The illumination of human consciousness through literature, philosophy, music, and the arts enriches the experience of individuals alone and as members of a community, allowing us to flourish fully as human beings.
us to flourish fully as human beings. The illumination and the inquiry are themselves intrinsic goods that thwart the notion of scientific knowledge as singularly capable of responding to the world’s challenges, precisely because they may turn out to be just as valuable in fostering a capacity to grapple with complexity that cannot be resolved through the scientific method.

As Feyerabend reminds us, true scientists are not scientistic—they possess a much more nuanced and complex understanding that sensibilities cannot be gained through scientific practices. Science is a tool to investigate metaphysical and epistemological claims. But, there is also value that comes from reflecting on experiences in a way that arouses the very sensibilities that enable us to deal with the metaphysics of being human and conscious of living in the world. The liberal education we offer to our students is a sensibility rather than a group of subjects. Good critics of literature can bring us into a sphere of experience that combines allusions to the past with what is happening in the world right now. Like philosophers, artists, and historians, they are capable of speaking to a universality of experience, and it is unnecessary to measure how many people were illuminated to understand the impact of what they offer. In the end, it is this phenomenological engagement with the liberal arts that is incapable of being translated through scientism.

**GIVING FACULTY THE NECESSARY TIME AND TOOLS**

To successfully incorporate this type of integrative learning into curricula across institutions, faculty need to be given the necessary time and tools. Institutions must also examine their own structures, policies, and practices and take account of how these either hinder or facilitate integrative, evidence-based learning across curricula. Administrators and senior colleagues should recognize the value of this type of intensive teaching, advising, and cross-disciplinary collaboration in the tenure and promotion process. Disciplinary silos, traditional standards of practice pressuring faculty to publish narrow peer-reviewed journal articles above all else, and program contribution analyses that do not give sufficient credit for collaborative teaching and research can create obstacles to implementing a STIRS curriculum and should be examined. In the process, faculty and administrators should be encouraged to come together to discuss whether there is a need to revise existing reward structures to support emerging innovative pedagogies.

Experiences in the world are neatly compartmentalized to conform with departmental and divisional modes of thinking. The blurred lines of the challenges students will face upon graduation should be mirrored in the problems on which we ask them to practice through curricular and cocurricular activities. Regardless of one’s major, the capacity to apply knowledge across disciplines, using multiple perspectives offered by those from radically different backgrounds, is a necessity in our rapidly changing, globally interdependent world. STIRS provides a framework for promoting quality in liberal education and inclusive excellence by ensuring that all students have the tools necessary to thrive in a future we can only partially comprehend.

**REFERENCES**


AC&U’s Scientific Thinking and Integrative Reasoning Skills (STIRS) framework is designed to guide the development of curriculum in evidence-based thinking. This framework has been developed, used, and revised as part of the LEAP Challenge, leading to capstone and signature work. The STIRS project was developed as an exemplar of integrative liberal education.

WHAT IS THE STIRS FRAMEWORK?
The STIRS framework consists of four components designed to fit together as part of an integrative bachelor’s degree. The four components are

1. Evidence—What It Is and How It Is Used: Defining and using evidence across the disciplines
2. Research Methods: Obtaining and ensuring the quality of evidence
3. Evidence-Based Problem Solving: Using evidence to define and solve problems
4. Evidence-Based Decision Making: Using evidence to define options and make decisions.

The goal of the LEAP Challenge and STIRS is to graduate engaged and productive citizens who are prepared to address the critical challenges of the twenty-first century. Therefore, graduates in all fields of study need to be able to

- Apply an evidence-based problem-solving approach that moves from problem identification to identification of causal factors; evidence-based recommended solutions; and implementation and evaluation of outcomes, including the role of reflection.
- Apply an evidence-based decision-making approach, identifying elements that frame and drive decision making for problems in the sciences, social sciences, health, humanities, and the fine arts, including preprofessional education.


### FIGURE 1. MODEL OF INTEGRATIVE LIBERAL EDUCATION

Integrative Liberal Education

- **Cornerstone**: Broad and Integrative Learning
- **Connector**: Signature Work
- **Culminating Experience**: LEAP Essential Learning Outcomes
- **Synthesis**: LEAP Essential Learning Outcomes

- **CAPSTONE**: Synthesis
- **CULMINATING EXPERIENCE**: Signature Work
- **BROAD AND INTEGRATIVE LEARNING**: LEAP Essential Learning Outcomes
- **CONNECTOR**: Signature Work
- **CORNERSTONE**: LEAP Essential Learning Outcomes
Analyze the operation of complex systems using evidence and analysis of systems.

Analyze ethics issues which are inherent in research and the use of evidence.

Synthesize evidence to formulate responses to complex problems and/or make recommendations for new approaches to disciplinary and interdisciplinary issues.

The STIRS project has undergone several phases since its 2012 inception. The first phase developed the initial version of the STIRS framework. The second “case studies” phase, begun in 2013–14, identified thirteen STIRS Scholars and produced sixteen peer-reviewed case studies that were linked to the initial STIRS framework (Stanford 2016). The “institutional phase,” begun in 2015, identified four institutions that are developing, implementing, and evaluating integrative evidence-based learning models based on the STIRS framework as exemplars of integrative liberal education (Anthony 2016).

In 2015–16, the STIRS framework was revised to more formally include the humanities and fine arts and to provide a structure that more readily suggests ways to incorporate STIRS into integrative liberal education. This article reports on the STIRS framework that has emerged from this process.

**HOW DO THE STIRS COMPONENTS CONNECT WITH INTEGRATIVE LIBERAL EDUCATION?**

The STIRS framework is designed to outline the content and process areas that should be covered in an evidence-based curriculum using an integrative liberal education framework applicable to disciplines ranging across the sciences, social sciences, health, humanities, and fine arts. It should be applicable to preprofessional programs as well as degrees preparing for entry into the workforce.

The STIRS framework provides a guide for teaching evidence-based thinking throughout the bachelor’s degree. As such, the framework must be hardwired to an integrative liberal education approach to bachelor’s degree education that interdigitates the general education or essential studies with majors or specialized knowledge.

Figure 1 (see p. 8) represents an AAC&U-endorsed model of integrative liberal education which intentionally links general education and essential studies with specialized knowledge or majors. To accomplish this goal, the model focuses on three levels of interaction labeled cornerstone, connector, and capstone.

To connect the STIRS framework to integrative liberal education, it was essential that the framework be structured so that the relationship of the components to the cornerstone, connector, and capstone elements of the liberal education model were obvious and provided ample opportunity for creative ways to implement the framework.

**WHAT ARE THE COMPONENTS OF THE STIRS FRAMEWORK AND HOW DO THEY FIT TOGETHER?**

The four components of the STIRS framework fit together in ways that allow them to be hardwired to the integrative liberal education model. The components and their links to the cornerstone, connector, and capstone approach are illustrated in figure 2.

Thus the STIRS framework suggests the need for a scaffolded approach aiming to achieve a coherent whole by using multiple components strategically distributed throughout the bachelor’s degree.

**WHAT ARE THE STIRS FRAMEWORK OUTCOMES?**

From the beginning, the STIRS framework aimed to make critical and analytic thinking more precise, more expansive, and more applied. The STIRS framework aims to facilitate communication, curriculum planning, and eventually curriculum evaluation in the area of evidence-based thinking.

In order for the framework to serve all of these purposes, the terms used in the framework need to be defined. This is especially important since the scope of application of the STIRS framework stretches from the sciences to the fine arts, fields that rarely have talked to each other using the same language or even the same meaning for the same words. Therefore, the STIRS framework includes over eighty definitions of terms designed to promote a common language for communicating key concepts.

The STIRS framework is not a set of specific learning outcomes. Rather, it aims to define the “enduring understandings” that all students should retain from their bachelor’s degree education. The four
Evidence—What It Is and How It Is Used
1. Reductionist approaches to the use of evidence
2. Integrative approaches to the use of evidence
3. Theories and paradigm shifts
4. Uses and display of evidence
5. Roles of statistical reasoning
6. Roles of analytical, intuitive, and logical reasoning

Research Methods
1. Qualitative and quantitative evidence
2. Data collection and analysis
3. Assignment to groups and assessment of outcomes
4. Interpretation criteria for cause and effect
5. Extrapolation
6. Ethical principles for research

Evidence-Based Problem Solving
1. Approaches to evidence-based problem solving
2. Problem framing and description
3. Etiology/efficacy and evidence-based recommendations
4. Implementation and evaluation
5. Methods of evidence-based problem solving, such as data synthesis and translational research

Evidence-Based Decision Making
1. Heuristics and decision rules
2. Comparing benefits and harms
3. Principles of testing
4. Prediction and prediction rules
5. Methods of evidence-based problem solving, such as data synthesis and translational research
6. Ethical principles for decision making

Component 1: Evidence—What It Is and How It Is Used

Subcomponent 6: Ethical principles for research
Research needs to be conducted based on ethical research principles including the principles of respect for persons, beneficence, and justice. These require prior review of research proposals by an objective external body, high-quality research designs, informed consent for human interventional research, and an expanding set of safeguards to ensure ethical implementation. Ethical standards for animal and laboratory research also need to be established and maintained.

This subcomponent emphasizes the connection between ethics and other humanities with the types of research methods that are increasingly applied in the sciences, social sciences, and health. It puts forth the now traditional principles of ethical research and emphasizes that high quality study design is itself an ethical imperative. Ethical standards in the conduct of research as well as its design are emphasized.

Component 2: Research Methods

Subcomponent 2: Integrative approaches to the use of evidence
Integrative approaches often build upon reductionist approaches. Integrative approaches draw from multiple disciplines incorporating multiple influences or determinants of outcomes; look for interactions between factors; and use evidence-based approaches to understand and propose strategies for addressing complex problems. Integrative approaches aim to model the multiple influences or determinants of a single outcome rather than test a hypothesis. In doing this they view outcomes as the results of complex interacting systems. Reflecting on complex systems and questions before problems are posed and solutions considered is a key skill for integrative approaches.

This description of integrative approaches to evidence-based thinking highlights the complementary roles of integrative and reductionist thinking. It outlines roles that integrative thinking can play, which can be applied across a range of disciplines as diverse as meteorology, geography, anthropology, sociology, linguistics, history, and public health. This subcomponent also emphasizes the role of reflection, which is fundamental to the humanities and fine arts.

Component 3: Evidence-Based Problem Solving

Subcomponent 2: Problem framing and description
Problem framing requires the use of evidence. Discipline-specific evidence is often needed, including unique methods applicable to the humanities and fine arts. Specific details, such as the timeline, burden, and financial costs, can be central to describing the problem. Describing the problem may provide a framework for integrating available qualitative and quantitative evidence to define what is known. It may also assist in developing a strategy for producing additional needed evidence. Evidence that describes the problem may be used to generate hypotheses.

This subcomponent outlines the use of a widely applied step-by-step process of evidence-based problem solving. It then focuses on the essential issue of framing...
the problem, which often sets the agenda for how problem solving is approached. The important role that the humanities and fine arts play in framing problems is central to this subcomponent.

**Component 4: Evidence-Based Decision Making**

**Subcomponent 1: Heuristics and decision rules**

Heuristics or “rules of thumb” often govern human decision making due to humans’ limited ability to process large quantities of data. Heuristics are an essential part of everyday decision making but are prone to a range of analytical and logical limitations. Decision rules, such as maximizing expected utility and satisficing, provide an objective basis for combining harms and benefits and selecting between options as part of evidence-based decision making. Unique methods are used in the humanities and fine arts to describe and challenge conventional approaches to decision making, including understanding a text or historical event differently, which adds to the understanding.

Once again, this subcomponent seeks to link the contributions of the humanities and fine arts with the traditional analytical approaches to decision making. This subcomponent assumes an emerging understanding of human decision making including its strengths and weaknesses. This approach is taking on increasing importance for twenty-first-century students confronting technological decision aids and massive amounts of data.

**WHAT DOES THE STIRS FRAMEWORK IMPLY ABOUT IMPLEMENTATION?**

A common initial curriculum is often desirable. It should define and illustrate the use of evidence in a wide range of disciplines selected from natural sciences, social sciences, health, humanities, and fine arts. It should introduce students to the thinking processes in multiple disciplines and help them appreciate the fit between the disciplines and their own interests and talents.

Integration of evidence-based thinking into a variety of majors and/or concentrations can facilitate accomplishing the remaining components. A synthesis or capstone activity, ideally including signature work, can ensure a coherent approach to integrating the four components of the STIRS framework.

**HOW WAS THE STIRS FRAMEWORK DEVELOPED AND REVISED?**

The initial STIRS framework was drafted by AAC&U’s Office of Integrative Liberal Learning and the Global Commons. The effort was led by former AAC&U senior director of global learning and curricular change, Kevin Hovland, with wide input, including that of the author of this article. The aim was to put forth a first approximation of the knowledge and skills that are central to applying evidence-based thinking to a wide spectrum of students in a broad range of disciplines.

From the beginning, definitions of terms were included in the framework in order to encourage communication using a common well-defined lexicon of evidence-based thinking terms. The initial draft framework was reviewed by the AAC&U STEM community through Project Kaleidoscope and the AAC&U general education community through the General Education and Assessment network.

The initial framework, developed in 2012–13, remained on AAC&U’s STIRS website for three years and guided the development of both the STIRS case studies and institutional phases. The use of the initial STIRS framework made it clear that it has two major limitations: (1) it did not explicitly integrate the use of evidence into the humanities or the fine arts and (2) it was not organized to hardwire to the cornerstone, connector, and capstone components of integrative liberal education.

Therefore, an intensive effort was made in 2015–16 to restructure and revise the STIRS framework to ensure that it was in sync with the integrative liberal education model increasingly being used by AAC&U. The revised STIRS framework also sought to explicitly and implicitly incorporate the humanities and the fine arts.

STIRS Scholars, STIRS Fellows, and AAC&U staff all provided feedback on the process. Additional feedback was solicited at the 2016 AAC&U annual meeting. Once drafted, the revised STIRS framework was announced in *AAC&U News* with an invitation to the entire AAC&U community to provide input. The revised STIRS framework, which is
HOW CAN THE STIRS FRAMEWORK BE USED?  
The STIRS framework has already been used to help organize the STIRS case studies. Each of these case studies was expected to illustrate one or more of the original STIRS framework components. The STIRS framework revision took place concurrently with the institutional phase of STIRS and benefited from the development of the cornerstone, connector, and capstone model of integrative liberal education upon which the institutional phase is built.

The STIRS Fellows also linked the STIRS framework with the AAC&U VALUE rubrics. Initially the STIRS project leadership refrained from developing an “evidence-based thinking” VALUE rubric, recognizing that the key components of evidence-based thinking were already dispersed through many of the VALUE rubrics. After some thought, however, the AAC&U VALUE rubric project team encouraged the development of an Evidence-Based Thinking VALUE rubric, which was created by adapting appropriate benchmarks from the other AAC&U VALUE rubrics.

Each STIRS Fellow is now developing and utilizing his or her own evidence-based thinking VALUE rubric. The next step is to compare them and then integrate these rubrics into each institution’s evaluation efforts. It is anticipated that the results of this process will be reported in the near future.

A key application of the STIRS framework is to utilize the components of the STIRS framework to scaffold the curriculum. For instance:

- **Evidence—What It Is and How It Is Used (Component 1).** This component can serve as the basis for a cornerstone curriculum. This curriculum might introduce students to basic principles of evidence and might be followed by discussions with faculty from a range of disciplines on their approaches to using evidence. This could allow faculty from disciplines as diverse as physics, economics, psychology, philosophy, architecture, and design to discuss what evidence means and how it is used in their discipline. A natural outgrowth of this approach is for the faculty to encourage students to try out their disciplines and for students to better understand whether their talents and interests are a good fit with a discipline.

- **Research Methods (Component 2).** Integrative liberal education requires explicit efforts to connect general education and the major. Research methods provide an excellent opportunity for this to occur. General education curricula are capable of engaging students in exploring basic principles of research design and analysis. The use of research methods in the major can then build on this foundation and apply discipline-specific approaches and tools for research.

- **Evidence-Based Problem Solving and Evidence-Based Decision Making (Components 3 and 4).** These components of the STIRS framework are the keys to applying the STIRS framework. They are also key to developing the types of problem-solving and decision-making skills that AAC&U has consistently found are sought by employers. These components can be illustrated in the major, but full implementation requires a capstone synthesizing general education and the major, which is ideally framed as a “signature work.”

As suggested in these examples, it is possible to hardwire the four components of the STIRS framework to the cornerstone, connector, and capstone components of the integrative liberal education model. One option for implementation is to develop the STIRS framework as a “Guided Learning Pathway” connecting evidence-based curriculum taken in two-year colleges with curriculum leading to signature work taken as part of a bachelor’s degree.

The STIRS framework as developed and widely reviewed might be said to have “face validity.” Face validity is a solid starting point but not the end of the process. Formal implementation and evaluation is needed before it can be said with confidence that the STIRS framework can be used as the structure for successfully teaching evidence-based thinking.

Therefore, another phase of STIRS is needed that could be called the “STIRS: Show Us the Evidence” phase. This potential next phase of STIRS will require larger scale planning; implementation; evaluation; and, if successful, dissemination. If successful, it will allow the next generation of college students to master the art and science of evidence-based thinking regardless of their institution or their major.

REFERENCES
The Scientific Thinking and Integrative Reasoning Skills (STIRS) project was developed as part of the Liberal Education and America’s Promise (LEAP) initiative, a national intellectual framework for liberal education principles, practices, and outcomes. STIRS specifically addresses the following LEAP Essential Learning Outcomes: inquiry and analysis, ethical reasoning, and integrative and applied learning. The project aims to help reinvigorate science and social science educational components for all students, not just those preparing for health professions. STIRS’s ultimate goal is to help students in all fields of study—in general education and in their majors—to understand and use evidence-based reasoning to solve problems and make judgments about important public issues.

In the first phase of STIRS, thirteen scholars from a variety of disciplines were invited to craft real-world, peer-reviewed case studies through which students could apply their understanding of scientific reasoning, study design, cross-disciplinary learning, and evidence-based problem solving within a course. The case studies (available since 2014 without cost from AAC&U at https://www.aacu.org/stirs/casestudies, along with their accompanying facilitator guides) are examples of how essential knowledge and skills can be connected and applied across disciplines and across general education and the majors—a key goal of LEAP.

At its 2012 launch, we envisioned that the STIRS project would last for only two years. However, interest in the project framework has caused it to exceed those expectations. In phase two of the project, four campuses are now piloting ways to scale up the evidence-based reasoning framework beyond the single course level. These pilots are using the STIRS framework as a foundation for thematic, scaffolded, four-year curricula capped by longer-term student projects. Expanding STIRS from a single class framework to a four-year program builds on the goals of General Education Maps and Markers (GEMs) and the LEAP Challenge, both initiatives that AAC&U developed while the initial STIRS work was under way.

The GEMs initiative emphasizes the importance of relevant, coherent, and integrative designs for general education that result in meaningful pathways to student achievement of learning outcomes and their own goals. The design principles that emerged from GEMs—proficiency, agency, self-direction, integrative learning, problem-based inquiry, equity, transparency, and assessment—are intended to inform a comprehensive reform of undergraduate education, beginning with general education but not ending there.

The LEAP Challenge, the next generation of LEAP, champions integrative and applied learning by focusing on students’ production of “signature work.” We define signature work as a project, requiring at least a semester to complete, in which a student synthesizes and applies learning by addressing a significant, complex, unscripted problem of societal and personal importance. Throughout the process of creating signature work, the student, guided and mentored by faculty members, takes the lead in framing and exploring a question and communicating the results of the inquiry.

Though there are a number of ways in which institutions can apply the GEMs principles and fulfill the LEAP Challenge, the case study assignments and broader programmatic designs emerging from the STIRS initiative serve as valuable examples of signature work and the intentional, coherent pathways needed to prepare all students to accomplish it.

It is our hope that in addition to inspiring assignment models and curricular design strategies, readers will take from this issue of Peer Review a sense of the importance of evidence-based reasoning for graduates in all fields, accomplished in part by connecting STEM skills across the curriculum. *
Promoting Evidence-Based Thinking Through the STIRS Case Studies

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The main goal of the AAC&U Scientific Thinking and Integrative Reasoning Skills (STIRS) project is to promote and support evidence-based thinking among college and university students (Riegelman and Hovland 2012). To help fulfill that need, a group of thirteen faculty members from across the country were selected to develop high-quality curricular materials to help instructors incorporate the STIRS framework into their courses. More specifically, these STIRS Scholars created peer-reviewed teaching case studies using a variety of topics that exemplify how the STIRS framework can be used to create engaging and effective student learning experiences.

THE NEED FOR CURRICULUM DEVELOPMENT TO SUPPORT EVIDENCE-BASED THINKING

It has been shown that many faculty do not use evidence-based pedagogical approaches in their classrooms (Bok 2006). Many significant barriers impede faculty from changing their teaching, including that they (1) are not rewarded as much for their teaching outcomes as for their research productivity, (2) are not always aware of the literature on effective pedagogical approaches, (3) have limited time to develop and implement new teaching activities, and (4) are uncomfortable with incorporating unfamiliar approaches in the classroom (Bok 2006; Wieman, Perkins, and Gilbert 2010; Brownell and Tanner 2012; President’s Council of Advisors on Science and Technology 2012; Byrne 2016).

In addition, well-developed teaching resources can be difficult to find, especially for the college level; those that do exist vary in quality and may not be suitable for many teaching contexts (Byrne 2016). Given these barriers, efforts to develop course materials that support faculty’s use of effective teaching approaches can help catalyze curricular change. Therefore, to encourage faculty use of materials that promote evidence-based thinking among students, it was critical to create a collection of materials that could be used in diverse contexts. The focus of the STIRS Scholars’ work was to create case studies reflecting the focal themes of the STIRS framework, especially ones that would help students improve their competencies for data analysis and evidence-based reasoning.

CASE STUDIES AS A CURRICULAR CONTEXT TO PROMOTE EVIDENCE-BASED THINKING

Case studies are a well-known active learning approach (Barnes, Christensen, and Hansen 1994; Miller and Tanner 2015). As revealed by many studies, active learning approaches promote greater student learning gains, more engagement with course content, and higher retention than lecture-based teaching approaches (Freeman et al. 2014). In addition, case-based learning allows students to think about content in the context of real-world problems or scenarios, which can increase student motivation for learning and help them improve intellectual skills (Hung, Jonassen, and Liu 2008; Miller and Tanner 2015).
Case-based learning is also a learner-centered approach. Learner-centered approaches can promote the retention of information by allowing instructors to understand student misconceptions, biases, and current grasp of concepts, and to address these issues (Gazzaniga, Ivry, and Mangun 2002; Johnstone 1997). Because there is more of a dialogue between students and instructors in student-centered teaching approaches, instructors gain better understanding of the barriers that may prevent students from absorbing certain information, and they are able to break down those barriers so that information reaches students’ working memory (Gazzaniga, Ivry, and Mangun 2002; Johnstone 1997). Further, learner-centered teaching methods can engender more energy and engagement in classrooms, making them more lively and the learning more enjoyable for students and instructors alike (Byrne 2016).

SELECTING THE STIRS SCHOLARS

The STIRS Scholars were selected on the basis of an application that required submission of a case concept proposal, a statement of interest, a curriculum vita, and a letter of support. Initial case ideas were based on STIRS Scholars’ research or teaching interests, or on a topic that a STIRS Scholar wanted to learn more about. Concept proposals included the case study topic, potential learning objectives, potential audiences, personal background with the case topic, examples of the types of evidence students would be asked to examine as part of the case, approaches the case would use to examine evidence, potential case format, and STIRS keywords and competencies addressed by the case. Thirteen STIRS Scholars were selected from a variety of disciplines, diverse institutions (e.g., small to large sizes, liberal arts to community colleges), and geographic locations. For a complete list of STIR cases and authors, see table 1.

The scholars who were selected included faculty from across the spectrum of academic ranks and leadership roles (e.g., assistant through full professors, a program director, and department chairs).

Developing the STIRS Cases

STIRS Scholars were charged with developing case studies to meet the following project goals:

- Engage learners in examining complex,
TABLE 2. BRIEF DESCRIPTIONS OF STIRS CASE STUDIES

<table>
<thead>
<tr>
<th>Title</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Different Times of the Month: A Cross-Cultural Analysis of Menstruation Taboos</td>
<td>This case focuses on analyzing attitudes about menstruation and culturally universal menstruation taboos in the context of different cultures and time periods and using cultural anthropology theory and methods.</td>
</tr>
<tr>
<td>The Two-Sex System: Fact or Fallacy?</td>
<td>Through this case, students explore whether society’s current two-sex paradigm (male/female) is an accurate reflection of existing sexual phenotypes and how this view affects those individuals who do not fit into the two categories.</td>
</tr>
<tr>
<td>Should English be the Official Language of the United States?</td>
<td>By examining data and readings, students investigate the implications of declaring English as the official language of the United States. Students explore key questions and their repercussions using evidence from the US Census, as they advocate and justify policy decisions.</td>
</tr>
<tr>
<td>Exploring Lawns and Gardens as Complex Socio-Ecological Systems</td>
<td>In this case, students are asked to examine the ecological and sociocultural context and implications of common lawn and garden management activities. Learning activities promote discussion of environmental science and sustainability studies topics.</td>
</tr>
<tr>
<td>People, Places, and Pipelines: Debating Tar Sands Oil Transmission</td>
<td>Students evaluate existing data and other information in this case to debate current environmental, economic, cultural, and ethical issues surrounding tar sands and tar shale oil transmission.</td>
</tr>
<tr>
<td>Organic Foods: Examining the Health Implications</td>
<td>Students consider evidence regarding how organic and conventionally produced foods vary in their environmental and occupational health impacts to explore issues relating to food, health, environment, and sustainability.</td>
</tr>
<tr>
<td>The (Ferret) Sneeze Heard Around the World: The Case of the Bioengineered Bird Flu</td>
<td>This case allows students to consider the controversy and debate policies surrounding whether or not to publish data describing how to successfully engineer the avian influenza virus to be transmissible between mammals.</td>
</tr>
<tr>
<td>Rising to the Challenge: Examining the Effects of a Growth Mindset</td>
<td>Concepts of a fixed versus growth mindset are considered in this case to understand differences in student academic achievement and how these differences can be addressed to promote academic achievement.</td>
</tr>
<tr>
<td>Preventing Spina Bifida and Other Neural Tube Defects</td>
<td>Through this case, students learn about neural tube defects, their causes, and the challenges in addressing the causes of these developmental anomalies. Students are challenged to make recommendations to address the problems arising from these conditions.</td>
</tr>
<tr>
<td>MMR Vaccine and Autism: Scientific Inquiry, Ethics, and Evidence-Based Problem Solving</td>
<td>This case centers on vaccines and vaccine safety, with a special focus on the MMR vaccine. The importance of vaccines and visualization of the societal impact of falling vaccination rates are emphasized.</td>
</tr>
<tr>
<td>To Drill or Not to Drill? A Dilemma in the Context of Climate Change in the Arctic</td>
<td>Students consider consequences of climate change and barriers to addressing climate change. Emphasis is placed on how students can contribute to addressing the problems raised in the case.</td>
</tr>
<tr>
<td>Cell Phones and Cancer: Evaluating the Evidence to Assess Potential Association</td>
<td>The relationship between cell phones and cancer is explored in this case. Students are encouraged to decide whether cell phones cause cancer and learn to make decisions about whether other environmental factors cause cancer.</td>
</tr>
<tr>
<td>The Role of Evidence in Emergency Health Care Policy and Law: Rory Staunton and NYU Langone Medical Center</td>
<td>This case centers on emergency medical care and the consequences of health law and policies as applied in the context of one patient’s complex and ultimately tragic case. Students discuss problems in emergency medical care from multiple perspectives, including law and policy.</td>
</tr>
<tr>
<td>Trends in Immigrant Adolescent Health in New York City</td>
<td>“Becoming an American Can Be Bad for Your Health.” Information from the fields of public health, anthropology, and history are brought together in this case, as students consider the implications of health issues faced by immigrant adolescents in urban America.</td>
</tr>
<tr>
<td>Blood Doping: Cheating or Leveling the Playing Field?</td>
<td>Students discuss the ethics of the use of performance-enhancing drugs in sports and compare and contrast this to other approaches used to improve performance. The science behind performance-enhancing drugs is emphasized.</td>
</tr>
<tr>
<td>Congressional Apportionment: Constitutional Questions, Data, and the First Presidential Veto</td>
<td>This case uses the topic of congressional apportionment to allow students to consider important historical, political science and mathematical concepts. Case activities support the development of conclusions centered on the 2000 US presidential elections.</td>
</tr>
</tbody>
</table>
multi-dimensional problems relevant to a wide variety of general education courses.

- Apply study design and statistical reasoning principles, or other relevant frameworks, to the evaluation of evidence.
- Ask learners to communicate effectively about issues raised by the case.
- Provide faculty with support in incorporating these cases into a variety of classroom environments.

STIRS Scholars attended a case writing training workshop that was held at an AAC&U General Education and Assessment Meeting in early 2014. In this workshop, STIRS Scholars were paired for peer support in the development of their cases. STIRS Scholars drafted a student case and facilitator guide, all of which were reviewed multiple times by both a mentor (Katherine Hunting) and a peer. Completed student cases and facilitator guides were subject to a blind review process with two peer reviewers, and each STIRS Scholar made final revisions based on reviewer feedback. The final versions of the peer-reviewed cases were published on the AAC&U website in January 2015 (https://www.aacu.org/stirs/casestudies).

Published cases include both a student case and a facilitator guide. Student cases include the materials that are provided to the students to support their learning and interaction with the case. This includes preparatory materials, learning objectives, a narrative that explains the case, background information, questions, suggested activities, and references. Facilitator guides were designed to support faculty in teaching the student case. Facilitator guides allow for the possibility that the instructor teaching the case is a novice in both the subject area and in case-based teaching. Facilitator guides include an abstract, teaching suggestions, answers to questions posed in the student case, additional background information as needed, ideas for assessing student learning, support for proposed student activities, an explanation of how the case links to the STIRS framework, suggestions of AAC&U VALUE rubrics that can be used to assess the case, references, and additional optional resources as needed.

THE STIRS TEACHING CASES

All STIRS cases focus on real-world problems and, due to the varied interests of the STIRS Scholars, the STIRS cases are topically diverse (table 1). Of note, three additional cases were developed prior to the selection of the STIRS Scholars by faculty who were instrumental in developing the STIRS cases. These authors are denoted by an asterisk in table 1. Additionally, two STIRS Scholars used their cases in a single, team-taught, cross-disciplinary course. These cases are denoted by a pound sign in table 1. Though the cases are topically distinct, they were all developed to follow the same basic principles, and thus cases emphasize skills such as evidence-based decision making, writing, research, presentation skills, group work, justifying a position, quantitation, ethical reasoning, scientific thinking, interpreting data, research study design, and interdisciplinary thinking. The student cases and facilitator guides can be downloaded from the AAC&U website (https://www.aacu.org/stirs/casestudies). All STIRS case materials are available at no cost, but to receive the facilitator guide, instructors must register and log on to the AAC&U website. Brief case descriptions are provided below in table 2, which will allow readers to identify the cases they might like to access and use in their own courses.

Using the STIRS Cases

The STIRS cases were designed to be used in a variety of contexts and in different types of classrooms. Many cases have suggestions within the facilitator guides about how to adapt them to be taught in general education versus discipline-specific courses, and about teaching in large or small classroom environments. Cases have flexible options for teaching, which are explained in the facilitator guides through suggestions for using selected parts or expanding via extended activities and follow-up assignments. Facilitator guides provide ample material to support the instructor in teaching these cases. They provide additional background information to support the instructor in understanding the concept the case is based on, detailed sugges-
tions regarding case implementation strategies, and the author's answers to questions posed in the student case.

**STIRS Case Studies Outcomes**

Since publication on the AAC&U website in January 2015, the STIRS cases have received positive feedback. From January 2015 through January 2016, instructors representing more than 80 institutions from across the country have downloaded more than 230 facilitator guides. Because access to facilitator guides requires instructors to register and log-in to the AAC&U website, the number of downloads of facilitator guides is a good indicator of how many instructors have interest in implementing STIRS cases.

In addition to publication on the AAC&U website, STIRS cases are linked to the Degree Qualifications Profile (DQP) assignment library (http://assignmentlibrary.org/) through the National Institute for Learning Outcomes Assessment (NILOA). NILOA, along with the Institute for Evidence-Based Change and the Lumina Foundation, developed the DQP to identify the common learning outcomes that students should have upon graduation from undergraduate- or master’s-level programs (http://degreetracker.org/).

The DQP assignment library is a repository of peer-reviewed assignments that are intended to support instructors in teaching and assessing the defined DQP learning outcomes to determine whether students are gaining competence in these areas. According to the infographic on the DQP website (http://degreetracker.org/quick-facts/), more than 400 institutions are using the DQP. As a result, inclusion of the STIRS cases as part of the DQP assignment library should drive both interest in and use of these cases.

**CONCLUSION**

The work of the STIRS Scholars is an important first step in promoting the goals of the STIRS project. The sixteen cases (table 1) represent peer-reviewed, pedagogically sound approaches to enable instructors to more easily incorporate evidence-based thinking into their courses. Already, the cases have allowed the STIRS Scholars to begin to transform their own teaching (Stanford et al. 2016) and have begun to inspire and enable other instructors from across the country to do the same.

More work is still needed to develop curricular materials to broadly support the incorporation of this method of teaching and thinking into the classroom, which will allow for sustained inclusion of evidence-based reasoning skills in higher education teaching. Hopefully, the STIRS cases described above provide exemplary models for how case-based teaching can be used to help students develop essential scientific-thinking and evidence-based reasoning skills.

**ACKNOWLEDGMENTS**

The STIRS Scholars would like to acknowledge Kevin Hovland, who helped to create the STIRS initiative at AAC&U and managed its initial implementation; Richard K. Riegelman, who developed the STIRS framework and supported this idea through AAC&U; Bethany Sutton, Kathy Wolfe, Lisa Russell O’Shea, and David Paris for their efforts to support the STIRS Scholars and the case studies project; Elizabeth Dickens, who collected data to support our understanding of the impact of this project; Pat Hutchings, who helped to link the STIRS cases with the DQP assignment library; and AAC&U for financial support for this project through an anonymous donor.

**REFERENCES**


The second phase of AAC&U’s Scientific Thinking and Integrative Reasoning Skills (STIRS) initiative, known as the Institutional Phase, was launched in 2015 as the next step in advancing the original STIRS program. Both phases of the initiative have the ultimate goal of drawing “national attention to evidence-based reasoning and decision-making as critical, multifaceted, cross-cutting capacities to be practiced by all undergraduate students in all degree programs” (Hovland and Riegelman 2012). In the Institutional Phase, AAC&U seeks to scale-up case study assignments to facilitate complete curricular reform that incorporates intentional, scaffolded curricula and utilizes evidence-based reasoning at every level of learning, culminating in student signature work.

Five STIRS Fellows were selected from four national institutions to pilot this curricular revision. As a team, they began sharing resources that would inform the curricular work at each institution. The four institutions represented by this cohort include Mercer University, Middlesex Community College, Oregon Institute of Technology, and the University of North Dakota. These STIRS Fellows met originally in July 2015 at the AAC&U Summer Institute on Integrative Learning and the Departments, and they have since continued to share ideas and resources as part of their work.

PROJECT DESCRIPTIONS

A key component of the fellows’ work at their home institutions has been creating cohorts of faculty and administrators to review and implement the reform suggestions provided by the fellows themselves. In each instance, the goal has been to create curricular components that can be piloted or enacted within the 2016–2017 academic year. As expected, the work has proceeded in different ways at each institution. Following are brief descriptions of the projects, recommendations, and actionable items that have taken shape for each STIRS Fellow.

Mercer University: Pathways to Signature Work for Nontraditional Students

Mercer University’s Penfield College offers undergraduate, graduate, and professional degree programs designed to serve a nontraditional—adult-learner and transfer—student population. Because Mercer designed Penfield specifically to serve traditionally underrepresented students, the college’s undergraduate program is uniquely poised within the larger institution to adopt the STIRS framework in a way that serves what is now being recognized as the new student majority in the United States.

With a vertically integrated curricular structure in place for its general education courses and most of its majors, Penfield viewed the STIRS framework as an opportunity to articulate existing pathways that would enhance students’ capacities for producing signature work in their capstone courses. Two majors, Liberal Studies and Informatics, were selected to pilot the STIRS framework to enhance their students’ capacities to produce signature work that clearly integrates general education outcomes with competencies specific to their majors.

By design, both the Liberal Studies and Informatics programs have vertically integrated core courses, including capstones, that students cannot transfer into the majors. However, both majors have been considering ways to improve the quality of work produced in the capstones by reinforcing the connections—in terms of both interdisciplinary and disciplinary-specific competencies—between...
courses leading up to the capstones. In the 2015–2016 academic year, the Liberal Studies and Informatics departments formed a joint cohort to adapt the STIRS framework to their majors. The anticipation was that by scaffolding core courses in terms of a STIRS-inspired benchmark-milestone-capstone series designed around specific capacities and assignments, the departments could establish clearer pathways toward the capstone experience within their existing curricular structures.

In spring 2016, the cohort defined the capacities within each discipline that signature work should promote and then utilized the STIRS focus on evidence-based reasoning as the common thread for scaffolding competencies from benchmark to milestone to capstone within the core course series. After aligning capacities for evidenced-based reasoning with each tier of courses in the series, the cohort determined that a peer review of assignments would be conducted over the summer to establish what type of assignment frameworks would be best suited for achieving these capacities in an intentionally scaffolded way. The cohort anticipates piloting these freshly articulated pathways in the 2016–2017 school year by being intentional with advising students to take courses in the appropriate sequence and by implementing the evidenced-based, peer-reviewed, and scaffolded assignment frameworks identified in 2015–2016. By embedding rubrics and assignments in the Digation eportfolio system, the cohort will continually track and assess the degree of success of these efforts.

Middlesex Community College: Creating an Integrated, Outcomes-Based Curriculum through Scaffolded Signature Work

Middlesex Community College (MCC) is a comprehensive community college located northwest of Boston, Massachusetts. In 2010, Middlesex began work to provide a more scaffolded, integrative general education curriculum, revising it to more directly support student achievement of MCC’s six Institutional Student Learning Outcomes (ISLOs). After much deliberation, the college moved from a distribution, input-based model of infusing content into designated courses to an integrative, outcomes-based model in which students’ competency with ISLOs is intentionally developed and assessed throughout the general education curriculum.

Complementing this work, MCC maintains a constant focus on the vertical alignment of its curricula and learning outcomes with transfer partners. They have collaborated extensively with the University of Massachusetts Lowell for this purpose. Faculty from both institutions have used backwards design from baccalaureate degree disciplinary expectations to develop signature assignments that reflect students’ increasing fluency with complex, contextualized essential learning outcomes. In each case, baccalaureate expectations have included students’ ability to apply evidence-based problem-solving approaches to frame problems in the field, generate evidence-based strategies for addressing these problems, and evaluate possible outcomes. This collaborative work between the community college and university has helped to facilitate students’ scaffolded development of those skills as they progress towards capstone work in the degree, represented by their signature work in “cornerstone” and “connector” courses typically taken by students in their first and sophomore years.

The STIRS initiative provides a framework for the college to continue improving the capacity of undergraduate students in all fields of study to use evidence to solve problems and make decisions. Contextualized to MCC’s Liberal Arts and Sciences Psychology Concentration, the project goal is to create a coherent, integrated curriculum culminating in a capstone experience that will serve as a model for other liberal arts and sciences concentrations. The project aligns tightly with the psychology concentration’s primary student learning outcome, “Students will move from relying on ‘common sense’ or biased patterns of thought to an ability to ‘make sense’ of observations, problem-solving to effectively use the scientific method and critical-thinking approaches for these same purposes,” developed in alignment with the American Psychological Association Guidelines for the Undergraduate Psychology Major. In addition, the project supports the Massachusetts Academic Transfer Pathways Project that is improving system-wide agreement about students’ learning and disciplinary competencies as they navigate from community colleges to baccalaureate institutions.

As part of this project, behavioral sciences faculty are developing a library of peer-reviewed “cornerstone” and “connector” (milestone) assignments designed to generate students’ signature work at scaffolded levels of complexity before progressing to capstone work at the baccalaureate level. In the fall of 2015, faculty used backward design to create signature assignments in five courses in order to build competency with contextualized essential learning outcomes. Outcomes were introduced in Introduction to Psychology and Introduction to Sociology; reinforced in Child Psychology and Abnormal Psychology; and mastered in Research Methods in Behavioral Science, the associate degree capstone course for the program. Faculty members piloted the assignments in the spring of 2016 and assessed the work using a locally developed rubric based on LEAP Value Rubrics including Critical Thinking, Problem Solving, and Quantitative Literacy to determine the degree to which students’ ability to use evidence to solve problems and make decisions increased in complexity during progress towards the associate degree.
indicate that students are developing increasing competency from introductory courses, preparing them to transfer into the capstone course. In 2016–2017, work will continue using the college’s assignment design to include additional courses and faculty.

Longer-term goals include scaling this work to other programs, beginning with those that also offer significant numbers of general education courses, in order to affect the greatest number of students as quickly as possible. The STIRS focus on scientific thinking and integrative reasoning skills is a representation of MCC’s Critical-Thinking and Problem-Solving ISLO, and as such is relevant within and across general education and all disciplinary programs.

Oregon Institute of Technology: Inquiry & Analysis as a Vertically Integrated General Education Pathway
Oregon Institute of Technology (Oregon Tech) is a small public polytechnic university focusing on undergraduate education in engineering, health technologies, management, and applied sciences at multiple campuses across the state of Oregon and online. In 2013, the university began a comprehensive review of its general education program with the aim of bringing its rationale into clear alignment with institutional goals.

A central component of this effort was the revision of Oregon Tech’s university-wide student learning outcomes; six outcomes were identified and given definition by faculty teams: communication; ethical reasoning; quantitative literacy; teamwork; diverse perspectives; and, most germane to the STIRS effort, inquiry and analysis. AAC&U VALUE Rubrics played a significant role in the work of defining and developing rubrics for each outcome. The revised model for general education, now termed “Essential Studies,” was structured around these six learning outcomes. Each outcome forms a developmental pathway from the foundational level—through practice both within and outside the major—and ultimately to capstone-level work that integrates all learning outcomes. The pathway associated with the Inquiry & Analysis outcome exemplifies this vertically integrated model. At the foundational level—in courses with no university-level prerequisites—students will be required to complete courses tagged as Inquiry & Analysis in the humanities, in the social sciences, and in the natural sciences. While this superficially resembles a traditional “distribution” model, in order to be listed as an Inquiry & Analysis course, a class must require students to engage in several of the elements of inquiry and evidence-based reasoning. For instance, in a foundational natural science inquiry course, students may not yet be prepared to pose their own questions and conduct their own analysis, but they might be involved in experimental design; in a foundational humanities class, students might advance their own thesis and provide supporting evidence, but their methods might not be fully grounded in the theoretical frameworks of their discipline.

At the intermediate (practicing) level—courses for which a foundational inquiry course is prerequisite—students will be required to deepen their skills in inquiry as scaffolding around the inquiry process is removed. This will occur both in courses from outside the major, selected as electives by students (providing opportunities for student-directed “pathways” in general education), and in courses within the major discipline that are identified by each program.

As a capstone to the Essential Studies program, the junior-level Essential Studies Synthesis Experience, a new concept for Oregon Tech, will provide an opportunity within the curriculum for students to apply all six learning outcomes and work in teams to tackle interdisciplinary questions and problems.

A faculty team is currently working to identify how existing university activities (such as international programs, service learning, and undergraduate research) and new types of activities can be adapted to meet this need. Faculty anticipate this program will also enhance students’ readiness for tackling inquiry in their major within the traditional disciplinary capstone taken in their senior year.

To build common understanding of all learning outcomes, faculty workshops, beginning in 2015 and led by faculty participants in the Multi-State Collaborative to Advance Learning Outcomes Assessment, have included “norming” exercises evaluating and discussing Oregon Tech student work using AAC&U VALUE Rubrics. Additionally, over the course of the past two academic years, faculty across all programs have participated in multiple exercises to map their curricula to the institutional learning outcomes. These activities have helped prepare faculty for the work that is currently starting in earnest—submitting courses for “tagging” as supporting a learning outcome. Through the tagging process, faculty and departments are identifying the types of assignments that satisfy an outcome’s general criteria in their specific courses—information that will facilitate later work in assessment and iterative improvement.

Oregon Tech’s faculty development committee will be working over the coming academic year with the teams for each learning outcome to assist faculty with the revision of existing courses or the development of new courses, as needed—for example, helping faculty integrate inquiry-based teaching approaches in laboratory classes—through a continuing series of workshops that include sharing best practices and discussing student work.

Finally, as part of this process, academic leaders at Oregon Tech came to view the interrelationship of our assessment, faculty development, and general education efforts as key to the ultimate success of this general education reform. As a result,
Oregon Tech has restructured the university committees involved in these three areas to enhance communication between them and the learning outcome committees as the university moves towards full implementation of the new Essential Studies model slated for the fall of 2017.

University of North Dakota: Integrated Studies Pathway

Seeking to overhaul an existing Interdisciplinary Studies major within the College of Arts & Sciences, fellows from University of North Dakota (UND) proposed reshaping the major by utilizing an existing well-established and very successful first-year learning community called the Integrated Studies Program as an entry point to an interdisciplinary studies major for first-year students. UND’s general education program, Essential Studies (ES), already contained a mandatory capstone requirement, and thus two key components—situated at the beginning and end of an interdisciplinary degree program and both involving aspects of general education—were already in place.

Because of these existing curricular pieces, it was relatively straightforward to imagine how the structure and lens of STIRS, with its emphasis on evidence-based reasoning, scaffolded learning practices, and culminating signature work, could provide an excellent framework for an interdisciplinary major serving first-year students.

The newly revised major now combines the Integrated Studies first-year program with intentionally crafted upper-level courses that emphasize how knowledge and evidence are acquired and acted upon within the disciplines. In addition, a new capstone course was created that capitalizes on the interdisciplinary experiences of students in the program, asking them to find common ground to address a topic of interest or concern and present their findings in both an oral presentation and a coauthored paper.

An important consideration that emerged through this work was the need for an entry point into the Interdisciplinary Studies curriculum for non-first-year and transfer students. By taking account of this need, an unanticipated—but we believe very fortuitous—outcome has emerged: a mechanism to address the needs of undeclared students who have reached junior status without a major or focus of study, and thus who find themselves at risk for a delayed graduation, or in some cases, no degree attainment at all. And through anecdotal information from academic advisors, those students in this group can often finish with a four-year degree that has little coherence or meaning.

The new STIRS-based courses created for this major will provide students in upper-level classes with a way to make sense of their learning and will encourage them to engage in intentional academic inquiry that emphasizes evidence-based reasoning and integration of knowledge. Using existing faculty from the Integrated Studies Program, this newly crafted Interdisciplinary Studies major is currently being piloted for first-year students as well as students in the upper-level classes.

Reflecting on Common Features

While the shape of fellows’ individual projects addressed the needs and strengths of their particular institutions, similarities exist and include a cornerstone/capstone structure, deliberately connected through courses or assignments focused on evidence-based reasoning, which include the scaffolding necessary for students to successfully progress through increasing levels of sophistication to a degree that meaningfully incorporates the general education program. That these common features exist across varied programs and institutions may suggest a potential for generalizability, and certainly one goal of this article is to help faculty and administrators see ways in which they can use the STIRS framework to benefit their students.

Of course, some may want to have a sense of how well the projects described here are working before making changes of their own. To help with that, the STIRS Fellows intend to develop—using the AAC&U VALUE rubrics—a tool that can be used to assess student work relative to evidence-based reasoning. Other ways to measure the success of fellows’ projects could include the number of students enrolled in the programs described above, information related to degree progression and completion, transfer readiness, and/or student engagement measures such as the NSSE. Although specifics will vary by fellow, another point of consistency is the need for mechanisms to assess each project’s success. Given that implementation is only now occurring, some of these metrics are not yet available. Continued work at each fellow’s institution will ultimately provide these necessary assessment results.

As a final point about consistency, it is worth noting that across the two STIRS phases a consistently diverse group of faculty have been interested in the project. The humanities, social sciences, and STEM disciplines are well represented in this group. And in each case there is a focus on developing mechanisms to help students become more adept at understanding and using evidence to reason, to pose and solve problems, and to make decisions. For these faculty members, there seems to be a shared sense of the importance of educating our students to become better “consumers” of evidence—a goal clearly consistent with any world-class liberal education.

REFERENCES


Actual and Potential Uses of STIRS Case Studies in Courses and Curricula

Jennifer S. Stanford, assistant professor, department of biology, codirector of the Center for the Advancement of STEM Teaching and Learning Excellence (CASTLE), Drexel University
Tami Carmichael, professor and director of humanities and integrated studies, University of North Dakota
Ryan J. Zerr, professor, department of mathematics, director of essential studies, University of North Dakota
Loren Byrne, associate professor, department of biology, marine biology, and environmental science, Roger Williams University

Case studies are valuable, engaging pedagogical tools that provide realistic examples of problems to be solved and help students to develop a variety of important skills (Peden 2015; Herreid 2005; Bonney 2015; Barnes, Christensen, and Hansen 1994). They can also be used to help students mature towards producing what AAC&U refers to as “signature work,” significant projects that are used to help students engage in assimilating and using what they have learned (Peden 2015). The AAC&U Scientific Thinking and Integrative Reasoning Skills (STIRS) Project has produced sixteen peer-reviewed cases that instructors can use to incorporate the STIRS framework into their courses (Stanford, Byrne, and Hunting 2016; Riegelman and Hovland 2012). In this article, we describe the intended use of these cases, examples of how they have been used thus far, and potential future use and analysis of these cases.

USING CASE STUDIES TO IMPLEMENT THE STIRS FRAMEWORK

The STIRS framework centers on evidence-based thinking, including understanding what evidence is and learning how to gather and evaluate evidence, how to use evidence to solve problems, and how to use evidence to make decisions. To encourage students’ evidence-based thinking, it is important to integrate these components into a general education curriculum to ensure that undergraduates practice these skills throughout their college experience. In the STIRS framework, this is achieved through the implementation of scaffolded “cornerstone,” “connector,” and “capstone” experiences. In brief, cornerstone experiences establish a foundation in evidence-based thinking, connector courses help students draw connections between their general education and major-related education, and capstone experiences promote integration of knowledge and application to real-world problems.

The cornerstone component of the STIRS framework can be implemented using a range of what AAC&U calls high-impact practices. These include first-year seminars and experiences, learning communities, writing intensive courses, collaborative assignments and projects, as well as diversity and global learning (Kuh, O’Donnell, and Reed 2013). The connector component of the STIRS framework can be fulfilled in research methods courses, which help students to think about how to gather and evaluate evidence. The capstone component of the STIRS framework is where students complete signature work.

STIRS case studies are a tool that can be implemented in these cornerstone, connector, and capstone experiences.

Some of the STIRS case studies can be used as part of cornerstone, high-impact practices. For example, “The Two-Sex System: Fact or Fallacy” case study (Bauer 2015) recommends that it be used as “collaborative, student-centered assignments in which students work together in class to solve problems. . . . The case study in its entirety addresses diversity issues in that the readings and documentary encourage students to explore life experiences that may differ from their own. This interdisciplinary case study also contains a writing
intensive component, another high-impact practice. Finally, this case study would be an ideal component of high-impact practices such as *first-year seminars* and/or *learning communities*, particularly those that address diversity issues."

A number of the case studies can contribute to teaching the connector component of the STIRS framework. Singer-Freeman’s case, “MMR Vaccine and Autism: Scientific Inquiry, Ethics, and Evidence-Based Problem Solving,” for instance, “teaches topics in scientific thinking and evidence-based reasoning, including the consideration of ways in which evidence can be used to advance knowledge, the application of design and statistical reasoning principles to the evaluation of evidence, and the analysis of ethical issues which are inherent in research.” These skills are appropriate to introduce in the context of a research-methods course, as well as in other connector course contexts.

The capstone component of the STIRS framework focuses on putting evidence-based problem solving and decision making into practice. Evidence-based decision making requires students to frame options and make decisions while taking into account the probability of benefits and harms and the importance and timing of these outcomes. Several of the STIRS case studies could be used to introduce a capstone or signature work curriculum. For instance, “Preventing Spina Bifida and other Neural Tube Defects” (Riegelman 2015) models the STIRS approach to evidence-based problem solving and illustrates the potential impact of the simple intervention of increasing folic acid consumption. Another example is the case “To Drill or Not to Drill? A Dilemma in the Context of Climate Change in the Arctic” (Singh 2015), which illustrates issues that arise when making politically, economically, and environmentally difficult decisions, and demonstrates how evidence can be used to more effectively guide the debate.

The cases developed as part of the STIRS initiative are not intended to be comprehensive or complete in addressing the STIRS framework in all curricular contexts. However, they do illustrate the multiple ways that cases can provide opportunities to engage students in evidence-based thinking within the curricula of an integrative bachelor’s degree.

**INTENDED USES OF STIRS CASE STUDIES AS ENVISIONED BY THE AUTHORS**

STIRS case studies have been intentionally designed to teach students to use evidence-based thinking in the context of societally relevant topics and content from specific disciplines. The primary intention of these cases is to facilitate instructors’ ability to support students in their development of critical thinking skills. As a result, there are many similarities in the ways that the STIRS case study authors envisioned that their cases could be used by instructors. Most authors envisioned that case materials could be used in a wide range of course contexts from introductory-level general education courses to more advanced specialty courses. To allow implementation in upper-level, discipline-specific courses, additional activities are suggested in the facilitator guides to allow students to think about the case topic in greater detail, using more advanced terms and theories.

Case facilitator guides commonly include suggestions about how to tailor a case to different audiences, and about how to adapt the case in ways such as modifying case length, including specific pedagogical strategies, and incorporating student and/or instructor-specific learning goals. When writing the cases, authors did not assume that students or instructors would have prior knowledge of particular fields, methods, or approaches, and thus they provided helpful suggestions and materials to support case incorporation with different audiences and in diverse course contexts. Facilitator guides also include references for obtaining additional information about the topics. Taken together, the intended uses for the STIRS case studies are quite broad, permitting use in many course contexts.

**ACTUAL USE OF CASE STUDIES**

The STIRS case studies were first published online in January 2015 (https://www.aacu.org/stirs/casestudies). In their first year of publication, there were 237 unique downloads of STIRS facilitator guides by 102 distinct individuals from at least 87 unique institutions across the United States and one download from an institution in Canada. Accessing facilitator guides requires registration through the AAC&U website, and thus tracking downloads of these guides is a good means to accurately gauge the number of people who have a genuine interest in using these cases. The individuals who downloaded the cases represent a range of academic professions, including all faculty levels (adjunct faculty and visiting professors through full professors); administrators (department chairs, deans, and program directors); graduate students; postdoctoral fellows; consultants; and staff involved in curriculum design or support (outreach specialist, science consultant, lab coordinator, library director, and teaching fellows directors). They also come from a range of institutions, including community colleges, small liberal arts schools, large state-funded universities, historically black colleges and universities, and large research universities. Each case was downloaded at least five times, and four cases were downloaded twenty or more unique times. The maximum number of unique downloads for any case was thirty-four.

Although the STIRS case studies were published online in January 2015, the first case downloads occurred in May 2015, after marketing efforts by the AAC&U communications department. These actions included sending an email blast to 25,000 faculty and academic affairs administrators to advertise...
the case studies and publishing an article on the STIRS case studies in the May 2015 AAC&U News, an electronic newsletter. Over 60 percent of the total downloads in the first year of publication occurred in May and June 2015, corresponding with this marketing push. Interestingly, there was no appreciable increase in downloads when the STIRS case studies were described at sessions presented by the case authors and others at the January 2015 and January 2016 AAC&U annual meetings.

Anecdotally, some of the case study authors have been using their cases in their own courses and have seen STIRS case studies begin to be discussed in professional education listservs (e.g., the Association for Assessment of Learning in Higher Education listserv). The authors who have used their cases have had positive experiences thus far. Zerr used his case “Congressional Apportionment: Constitutional Questions, Data, and the First Presidential Veto” in a general education course focused on quantitative reasoning (Zerr 2015). Although data were not gathered to evaluate student learning, he noted that student reactions and engagement were very positive. This case juxtaposes content areas not often seen as clearly connected by students (history and historical writings with quantitative information). Students remarked that they need more time than expected to complete the primary learning outcomes from the case, using Likert-type items to assess student perception of their learning (twenty-seven respondents). After completing the case study, student responses indicated statistically significant improvements in their self-perceived abilities to achieve the learning outcomes (Byrne unpublished data). The increase in students’ perception of their understanding suggests that the case study is well-placed in the context of Byrne’s course, and it effectively promoted student learning in this context. This fits with Byrne’s personal observations that students were engaged, performed well on case-related activities, and used case-related examples in discussions throughout the rest of the course. Stanford similarly studied student perceptions of their ability to complete course learning outcomes in a course that introduces the biology of cancer to nonbiology majors. She compared results from a survey conducted after two offerings of the course, one that did not use her case study “Cell Phones and Cancer: Evaluating the Evidence to Assess Potential Association” (sixteen respondents) and one that did use the case study (Stanford 2015). While students reported a greater ability to complete course learning objectives after engaging in a course offering that included the case, this outcome was not statistically significant, potentially due to the small sample size studied thus far (Stanford unpublished data).

Of note, in both iterations of the course, the average response indicated that students felt they could effectively complete course learning objectives. Importantly, we do not want to overemphasize these data, as they are from preliminary studies with small numbers of students, which were conducted by individual case authors to understand the effects of incorporating their case into their specific course contexts. However, these data do support other anecdotal data collected, which suggests that these cases can contribute to student learning. Additional work is needed to fully understand whether observed outcomes are replicable in these and other course contexts.

PLANNED INSTITUTIONAL USES OF CASE STUDIES BY STIRS FELLOWS

While the STIRS project began with the development of case studies, it has now progressed to the development of complete, STIRS-based curricula by five AAC&U STIRS Fellows (https://www.aacu.org/stirs-fellows). These individuals were chosen to help their institutions reimagine their general education curricula to incorporate the STIRS framework of scaffolded cornerstone, connector, and capstone experiences. The STIRS resources and methodologies provide models for strengthening evidence-based learning and creating more intentional learning pathways for undergraduates, whether the first step in curricular reform is to use case study assignments in particular courses or to attempt complete curricular revision.

As the institutional phase of the STIRS initiative has taken shape over the course of
the past year, evidence-based reasoning has been emphasized as a key curricular component. Of the four institutions involved in the second phase of the STIRS initiative (Mercer University, Middlesex Community College, Oregon Institute of Technology, and University of North Dakota), three have either used the STIRS case studies as a model for incorporating evidence-based reasoning into key assignments or have incorporated the case studies into connector courses that bridge initial learning experiences to capstone signature learning projects. At the University of North Dakota, the STIRS initiative has led to a newly renovated Interdisciplinary Studies major that has a focus on helping students to understand evidence-based reasoning across disciplines.

This major incorporates a vibrant and successful first-year learning program with a required general education capstone. Connector courses focus on exposing students to the types of questions that are asked broadly across disciplines, the methods used to find answers to these questions, and the points of intersection between disciplinary methodologies and frameworks. STIRS case studies are intended as an integral part of this curriculum. Since the STIRS case studies are interdisciplinary, accessible, and varied, they are perfect vehicles for engaging students in the work of evidence-based reasoning across disciplines. Because all of the STIRS case studies have been carefully constructed and peer-reviewed, there is standardization of the quality of these cases with regards to promoting student development of evidence-based reasoning. In this institutional context, case studies will be selected by individual course instructors based on how the case will allow the instructor to advance his or her learning outcomes.

Other STIRS Fellows are also looking to the STIRS case studies as part of their evidence-based curriculum revision efforts. The Middlesex Community College curriculum revision centers on the use of primary source, empirical research articles and other research-based evidence to help develop students’ evidence-based decision-making skills. After an initial round of assessment information is collected, curricular development will progress to the design and incorporation of another set of learning activities. The STIRS case studies are one of the options being carefully explored as a viable option for continued curricular development. Similarly, at Mercer University, STIRS case studies are being integrated within a pilot, introductory-level curriculum. Taken together, STIRS case studies are helping to facilitate institutional curricular changes intended to help students develop evidence-based reasoning skills.

**APPROACHES TO FUTURE EVALUATION OF CASE STUDIES**

At this time, the STIRS case studies have been published for fewer than two years. The very early outcomes regarding the use of STIRS case studies suggest that there is interest in using these cases in undergraduate curricula. Taking into account that the majority of case downloads took place after significant marketing activities by AAC&U, we hope that this issue of Peer Review will compel others to consider use of these free, peer-reviewed resources at their institutions.

Future evaluation of case studies should aim to involve multiple mechanisms of collecting data (Lundeberg and Yadav 2006; Lundeberg 2006; Bonney 2015). Using the information collected from downloads of STIRS facilitator guides, we can reach out to those who have downloaded these guides to identify who has actually used the cases and learn about their experiences. This would allow us to assess the scope of use and develop a greater understanding of how effective users have been in implementing these cases in their own courses. Data collection can initially occur through surveys and be followed up with interviews to construct a more complete understanding of the instructor experience. Ideally, we would also be interested in developing mechanisms to help instructors assess student competencies before and after implementation of a case. Not only could this serve as a mechanism to gather data on whether these cases are effective learning tools, but also could help faculty to demonstrate the effectiveness of their teaching (i.e., for promotion and tenure portfolios).

Additional work to assess outcomes of the STIRS case studies is warranted.

Though other case-study resources exist, the STIRS cases were developed using a unique framework and approach, with a specific focus on evidence-based thinking. While case-based learning has been established as a valuable learning approach in many contexts (Barnes, Christensen, and Hansen 1994; Miller and Tanner 2015; Hung, Jonassen, and Liu 2008), the specific approach used in developing STIRS case studies still needs to be evaluated. Careful assessment of the use and outcomes of the STIRS case studies will allow us a better understanding of whether these tools are useful resources for teaching within the STIRS framework. If so, it is our hope that this will justify the development of additional resources of this type. Tangibly supporting faculty in promoting scientific thinking and integrative reasoning in diverse classroom environments with readily available, high-quality pedagogical resources is essential to facilitate the incorporation of this type of thinking into the undergraduate classroom. Real change in the way that students are being taught will require sustained effort in curriculum development and sharing of curricular materials to support faculty teaching. These types of efforts could help institutions overcome the significant barriers that inhibit curricular change at the undergraduate level (Bok 2006; Wieman 2012; Brownell and Tanner 2012; Austin 2011).
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REFERENCES


Byrne, Loren B. Unpublished Data.


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The LEAP Challenge

This special double issue focuses on the LEAP Challenge, the next phase of AAC&U's Liberal Education and America's Promise (LEAP) initiative. Articles present the LEAP Challenge and, through exploration of a variety of campus exemplars, its central concept of Signature Work.

Faculty Leadership for Integrative Liberal Learning

By Ann S. Ferren and David C. Paris

Faculty Leadership for Integrative Liberal Learning articulates a set of principles and practices to guide integrative liberal learning for today's students. The overlapping principles reflect a more holistic concept of undergraduate education that focuses on student empowerment and self-development, intentionally integrated learning opportunities and experiences, and greater clarity and transparency of learning outcomes for students, faculty, and other stakeholders. The publication aims to elucidate the value and use of integrative liberal learning and the best pedagogical and faculty leadership practices to prepare students for applying their learning to complex challenges in life, career, and citizenship. This publication emerges from the work of the Teagle Foundation-supported Faculty Leadership for Integrative Liberal Learning: Principles and Practices project.

Peer Review Fall 2013

Capstones and Integrative Learning

Whether they’re called senior capstones or another name, these culminating experiences require students nearing the end of their college years to create a project of some sort that integrates and applies what they’ve learned. This issue shows examples of learning outcomes and best practices for capstone courses and programs.

Increasing Student Success in STEM:
A Guide to Systemic Institutional Change

By Susan Elrod and Adrianna Kezar

This report describes the Keck/PKAL Model for Systemic Institutional Change in STEM Education. It is intended for faculty leaders, department chairs, deans, provosts, and presidents who are interested in making significant shifts in how STEM programs are offered and for improving the recruiting, retention, and graduation of STEM students, particularly underrepresented minority students. The guide contains advice on getting started, team and leader development, project management, and sustaining change. It also includes benchmarks, key questions for analysis, timeline information, challenge alerts to help anticipate common roadblocks, and a rubric to help campus teams gauge their progress. Examples from case studies developed by campus teams who participated in the project provide real-world illustrations.

Student Success in STEM

Leadership for Interdisciplinary Learning:
A Practical Guide to Mobilizing, Implementing, and Sustaining Campus Efforts

By Susan Elrod and Mary J.S. Roth

This report translates the recommendations from What Works in Facilitating Interdisciplinary Learning in Science and Mathematics (see below) into a strategic flow of leadership actions. It offers campus leaders a roadmap for building—and sustaining—innovative interdisciplinary programs. The report includes a model to help institutional leaders anticipate and overcome significant barriers to institutionalizing interdisciplinary programs.
The ongoing digital revolution has created a complex and interconnected ecosystem that is fundamentally reshaping how we learn and communicate. Yet, despite its transformative potential, this digital ecosystem has so far had less of an impact on formal education than on other sectors of our society. Authors Randy Bass and Bret Eynon explore the implications of emerging digital capacities and culture for higher education, arguing that any discussion to reinvent higher education that begins with technology is doomed to a diminished vision of learning. Bass and Eynon begin instead by reimagining the core purposes of liberal education in this new context and ask: What is the role of the digital ecosystem in making a quality liberal education available to all, equitably?

Going beyond “unbundling,” the authors propose that we use networked and adaptive systems to “rebundle” higher education by connecting learning experiences that have typically been disconnected, opening the boundaries of institutions, and creating new integrative contexts for transformative learning. This publication includes examples of digital innovations that advance liberal education outcomes and is ideal for campus discussions on using digital learning to improve undergraduate teaching and learning. Chapter topics include:

- The Digital Challenge: From Disruption to Design
- The Digital Context: Features of the Emerging Ecosystem
- Digital Strategies: Engagement, Community, and Integration
- Learning Organizations: Faculty Development and Outcomes Assessment
- Design Principles for a Rebundled Institution
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The Courage to Create the Time for Reflection

Terrel Rhodes, vice president for quality, curriculum, and assessment, and executive director of VALUE, AAC&U

Ultimately, the greatest challenges facing higher education faculty and administrators involve time and courage. Many need time to rethink and to reflect upon course content, pedagogies, and learning outcomes, and to summon the courage to collaborate with colleagues to achieve the learning our students need. The preceding collection of articles illustrates how problem-based learning can become a central focus for student engagement and learning from course level to institutional framing and design.

Much has been written and heard in the media and at conferences about the value of personalized learning for the current and future generations of students in higher education. However, so often personalized learning translates into reductionist and atomized learning modules. These options are heavy on information transfer and discrete transmission of focused content. The result is personalized, but is this the model that higher education should follow?

I am not dismissing the advances and benefits of the digital environment we now inhabit. My point is that so much of what happens in the current rush to personalize and digitize education is not what a higher education liberal education is meant to do. A liberally educated person is one who not only knows and can access information or knowledge, but who also knows how to find information that (1) is grounded in evidence; (2) challenges the accepted or prevalent understanding; and (3) promotes engagement with others for debate and examination of usefulness, applicability, and common understanding. In short, learning is a process, a social interaction that needs to involve more than one’s self and a programmed set of algorithms.

For one to become competent at anything requires practice over time. It is a process that requires iterative engagement at progressively more sophisticated and complex levels of challenge and achievement. As faculty and educators, creating space to rethink how we spend our time with our students in and out of classes, what we ask them to do to demonstrate their learning, and how we connect their learning in context to all of the learning they bring with them is critically important. Important as a means to connect their learning to their individual experiences and interests, but also important for the connection and integration of new learning to the existing learning each student embodies.

Faculty and administrators also need to find the courage to reflect upon what we individually do in relation to our colleagues concerning students’ larger educational experiences. To that end, I contend that the STIRS framework is worthy of their consideration. The signature work illustrated through STIRS challenges students to formulate questions to investigate; to devise strategies to wrestle with contemporary and enduring problems through hands-on, untidy, and unscripted problems; and to integrate and make sense of their learning in a way that will last beyond students’ time on campus.
AAC&U is the leading national association concerned with the quality, vitality, and public standing of undergraduate liberal education. Its members are committed to extending the advantages of a liberal education to all students, regardless of academic specialization or intended career. Founded in 1915, AAC&U now comprises nearly 1,400 member institutions—including accredited public and private colleges, community colleges, research universities, and comprehensive universities of every type and size.

AAC&U functions as a catalyst and facilitator, forging links among presidents, administrators, and faculty members who are engaged in institutional and curricular planning. Its mission is to reinforce the collective commitment to liberal education and inclusive excellence at both the national and local levels, and to help individual institutions keep the quality of student learning at the core of their work as they evolve to meet new economic and social challenges.

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