Technology-Enhanced Learning: Best Practices and Data Sharing in Higher Education
Background and Scope of this Document

The Global Learning Council (GLC) is an organization of leaders in higher education, the technology industry and the nonprofit sector formed to promote the development and scaling of educational practices, policies and technologies aimed at substantially improving student learning outcomes.

The GLC believes that research-informed, Technology-Enhanced Learning (TEL) design and instruction can substantially improve these outcomes, and supports collaboration among institutions of higher education, schools, technology providers, philanthropic organizations, nonprofit groups and government agencies to achieve the immense promise of carefully designed technologies.

At its inaugural meeting held in Pittsburgh in September 2014, the GLC agreed on two problem statements and related action items upon which it would focus its efforts over the next year:

- **Problem Statement #1**: Practitioners do not have a trusted and understandable information source to help them implement evidence-based, Technology-Enhanced Learning in higher education.
  
  **Action Item**: The GLC will develop and disseminate understandable criteria and evidence for best practices in the following areas: (1) Design of learning environments; (2) Continuous improvement; (3) Adoption of new methods and technologies.

- **Problem Statement #2**: Many organizations gather large amounts of learning data and are willing to share these data for education and research. However, currently there is a lack of widely accepted principles and criteria for sharing data.
  
  **Action Item**: The GLC will create a framework with principles and criteria for the sharing of learning data.

This document summarizes the GLC’s proposed recommendations in response to these two challenges. While distinctive from one another, these topics are deeply interrelated, and are thus presented in one single document.

This initial draft is being circulated for discussion, comment and feedback in the higher education, technology industry, government and nonprofit communities.

Introduction: Opportunities and Challenges for TEL and Data Sharing in Higher Education

Many 21st century students receive a 19th century education that is developed without the benefit of existing evidence-based research. With appropriate data we cannot only unlock the mysteries behind how human learning works, but we can also improve education by producing learning experiences that are more effective, efficient and enjoyable.
Instructors are experts in their own disciplines but tend not to be trained in learning science, pedagogy or educational technology. So, fundamentally, applying learning science and designing Technology-Enhanced Learning (TEL) effectively demands that we acknowledge a gap in the current system and take steps to address it. When attention is paid to deliberate instructional design, faculty support and data-driven refinement, applying learning science to TEL design can consistently lead to enhanced learning outcomes for students. This learning-science based approach to education requires (1) a genuine commitment to a ruthlessly evidence-based, data-driven and iterative methodology and (2) an institutional infrastructure that fosters initiative and innovation. Intimately linked to such an approach is the need for the sharing of data, tools and methods that can be used to support the design and enhancement of TEL environments.

It is also important to be mindful of the global context of advancements in TEL. Technology is not only bringing interactive education to people around the world, it is bringing diverse perspectives together in common learning experiences. For example, there is interesting new scientific evidence that discussion groups on MOOCs with members from many different countries learn more than groups with one or just a few countries represented. Similarly, applying a science driven approach to TEL design should be informed by global perspectives and considerate of the cultural differences amongst learners.

Below, we have outlined our current views on the opportunities and challenges associated with implementing effective, outcome-driven approaches to TEL design and data sharing. We provide specific recommendations for action that may be used to maximize the potential for TEL to improve learning outcomes for all.

**Opportunity: Research-Based Instruction Significantly Outperforms Intuition**

Due to an extensive body of research in learning science and related fields, much is known about the mechanisms that underlie robust learning. This research provides guidance toward designing the most effective instruction and can be directly applied to improve the design, implementation and use of educational technologies. Leveraging this research in designing TEL is critical because learning is a complex process with multiple interacting factors whose combined effect is difficult to predict. Intuitive approaches to instructional design often produce poor learning outcomes, whereas research-based approaches have consistently produced significant improvements in learning effectiveness and efficiency.

**Challenge: Applying Research to TEL Design Requires Expertise, Adaptation and Iteration**

Significant obstacles make it difficult for faculty to apply learning science research in their instructional and TEL designs. (1) Faculty are trained to be experts in their discipline, not in learning science, research-based pedagogies or educational technologies. (2) Any design of new instruction or TEL requires adapting or extending past research results to the current context, and these adaptations can be effectively refined based on learning data collected from the given context. Failure is common in initial attempts but should be used to fuel refinement. (3) Faculty have limited time to engage in any of these activities, but they are key to the development of effective instruction. To lower these barriers, institutions need to build an infrastructure of support resources and incentives that will enable evidence-based education and continuous improvement to be standard practice.
Opportunity: Improved Education Requires Data and Data Sharing

Enormous quantities of educational data have been and continue to be created every day as the natural byproducts of student use of online courses, intelligent tutors, educational games, science simulations, as well as learning management systems and written (scanned) data. The high volume and diversity of data creates a unique opportunity to bring about long-lasting and positive changes in education. For the first time in our history, the collection and analysis of data from educational technologies allows us to widely employ evidenced-based education. Educational research repeatedly reveals how practices that yield results in one context are often not easily and reliably employed in other contexts. Sharing of best practices will be increasingly successful if we can also share associated data and analytics. Sharing of data and analytics fosters and supports research-informed adaptations and continuous improvement within local contexts. In the aggregate, shared learning data is essential to accelerate our understanding of human learning, providing unique opportunities for basic learning research at scale. However, to reach the revolutionary opportunities that sharing will make possible, we need to meet the challenge of ensuring students’ privacy in the process of data sharing.

Challenge: Sharing Educational Data Requires Securing Student Privacy

We have the responsibility to protect students’ privacy. Since educational data often contains sensitive information and that if the proper procedures and practices are not followed, the owners could be identified and a privacy threat could be created. To avoid the creation of a privacy threat, publicly available data should not provide additional information beyond what is already publicly known. As a guideline, principles and practices that should be employed when collecting data build on The Asilomar Convention for Learning Research in Higher Education, the 1973 Code of Fair Information Practices and the Belmont Report of 1979.

Recommendations: Support community in applying learning science in TEL design to enhance learning outcomes

New faculty practices are needed to support continuous course improvement that involves cycles of scientifically-based design, trials of TEL innovations, data collection and analysis and redesign. For changes in faculty practices to be significant and lasting, the campus culture must be transformed. These campus changes will be best achieved by sharing across campuses using technology platforms and data infrastructures that leverage lessons learned toward both advancing learning science and improving student outcomes around the world.

In the table on page 5, we have outlined specific actions that can be taken by university leadership in order to establish and sustain a social-technical infrastructure to enable effective practices in TEL design/teaching and educational data sharing. These recommendations involve a network of interactions between faculty, administration and the global education community (see Figure 1).
Figure 1. To create and support a culture of continuous improvement we need changes both within campuses in processes for producing better TEL and across campuses for sharing, adopting and adapting technologies, practices, data and scientific results.

Table 1. Build a social-technical infrastructure for research-informed TEL design and practice/teaching.

A Create a campus culture with incentives and professional development support.
1. Build on shared values of excellence and innovation by having institutional leaders actively espouse scientific approaches to education.
2. Adjust the incentives for faculty to engage in effective TEL design.
3. Educate and support faculty in incorporating research-based principles and practices in TEL design.

B Build expertise and resources to foster a cycle of continuous improvement.
4. Implement systematic procedures for designing TEL resources: Deliberate Instruction.
5. Build infrastructure for data collection to enable adaptive teaching and learning and iteratively improved instructional design.
6. Invest in a team of instructional-design and faculty-development experts.

C Pursue global community building and strategies for data and resource sharing.
7. Collect, develop and curate a repository of instructional and TEL tools and resources that are easy to use, share and customize.
8. Adopt and adapt a data repository and build collaborative interdisciplinary research communities devoted to improving learning outcomes through empirical research around data.
9. Commission a global, cross-sector task force with the goal of developing practices for securing student data privacy.
A Create a campus culture with incentives and professional development support

Collectively, faculty may recognize the value of research-based teaching and TEL design, but they decide individually whether or not to change a course or develop a new TEL resource. The calculus of these individual decisions naturally favors the status quo over paying a substantial price, in time and opportunity cost, to apply a scientific approach to education. Fundamental transformation has not yet come to fruition because change is hard. It takes time and effort — mostly on the part of already oversubscribed faculty members — and it is often obstructed by institutional barriers that discourage faculty from taking innovative risks in this area. Thus, our first recommendation is for university administrations to take actions toward changing campus culture (see #1 in the Table and Figure). In addition to voicing encouragement, we recommend changes to faculty incentives to reward faculty for investing time in applying learning science and in producing data that demonstrates improved student learning outcomes (see #2). Beyond motivating these actions through institutional values and incentives, we recommend that university administrations also provide instrumental assistance in the form of educational resources and support (see #3).

B Build expertise and resources to foster a cycle of continuous improvement

Engaging in evidence-based, iteratively improved TEL design requires new skills and new processes. So, enacting this new approach at scale — within or across institutions — will require lowering the barriers to change. Thus, we recommend that universities and colleges implement and support an approach we call “deliberate instruction.” This systematic approach emphasizes analysis and planning during the design of instruction, with four core components derived from research-based principles: cognitive task analysis, instructional alignment, repeated practice and targeted feedback (see #4). After design, the continuous improvement cycle for TEL involves collecting and analyzing learning data, so we recommend that institutions (or groups of institutions, see below) build tools and resources that make these steps easy and natural (see #5). Finally, we recommend that universities and colleges invest in instructional-design and faculty-development experts who can help faculty develop the skills needed for this work and collaborate with them in agile-development teams (see #6).

C Pursue global community building and strategies for data and resource sharing

To expedite these discoveries we recommend that colleges and universities encourage building communities around data and tool repositories (see #8). Creating or joining a collaborative research community devoted to improving learning outcomes through empirical research will aid in facilitating the design, improvement, comparison and dissemination of effective learning metrics, feedback mechanisms and best practices necessary to fuel a global learning revolution. As part of these communities, we advocate bringing together the expertise and resources of university, industry and government stakeholders to collect and store hundreds of high-quality data sets and accumulate the best analytic methods available for educational research. We encourage sharing to go beyond datasets and to also include assessments, educational technologies, educational technology authoring tools, analysis tools, research techniques and associated publications (see #7).
Faculty, curriculum developers, instructional designers and learning researchers should be encouraged to contribute so that all can benefit from their experiences and research. Learning scientists should be encouraged to test hypotheses and new analysis methods on hundreds of datasets contributed by others. Creating a data commons is a critical step in the success of the interdisciplinary research community and provides a unifying network for collaboration.

Different kinds of educational data come with a range of sensitivity to risks to student privacy. An example of low-risk data is simple mouse and keyboard interactions with an educational technology (so-called “click stream” data) where no student identifying information, such as name, address or demographics, is included and where there are no links to other datasets. At the other extreme, classroom or student video data that includes student identifying information is of high risk. Corresponding with the risk are different levels of data security and access. High storage security and limited access, for example, to only a small group of researchers with Institutional Review Board approval is appropriate for highly sensitive data. In contrast, for low-risk data more open access is reasonable. Thus, a one-size-fits-all policy is not appropriate. Instead, we recommend defining commonly agreed upon protections for each pairing of level of data sensitivity and sharing sensitivity. Accordingly, we recommend that a global, cross-sector task force be commissioned with the goal of specifying practices that relevant legal bodies (e.g., university IRBs, FERPA) can adopt to protect individuals’ privacy (see #9).

**Invitation to Comment**

The Global Learning Council is presenting this document to help achieve its goals of expanding awareness of the principles behind leveraging technology to improve learning outcomes. We hope to foster a world-wide discussion about how higher education can advance changes in the research-based design and use of learning technologies to produce significantly better learning outcomes for every student. Making such changes is not an easy task, and we invite informed comments, examples of the principles discussed, responses, suggestions or alternatives to the recommendations, and any other input on this discussion so far. Information on submitting examples of the principles and recommendations discussed in this draft document may be found at the GLC website (www.globallearningcouncil.org).

Comments and case studies may be submitted by email to info@globallearningcouncil.org.
Global Learning Council Members

SUBRA SURESH (Chair),
President, Carnegie Mellon University
ANANT AGARWAL,
Chief Executive Officer, edX
PATRICK D. GALLAGHER,
Chancellor and Chief Executive Officer,
University of Pittsburgh
ANoop GUPTA,
Distinguished Scientist, Microsoft Research
Rush HOLT,
AAAS Chief Executive Officer and
Executive Publisher, Science
Sal KHAN,
Founder & Executive Director, Khan Academy
Matthias KLEINER,
President, Leibniz Association, Germany
Daphne Koller,
Co-founder, Coursera
Peter MCPherson,
President, Association of Public and
Land-grant Universities
Hunter RAWLINGS,
President, Association of American Universities
Andrew ROSEN,
Chairman, Kaplan Inc.
Alfred Spector,
Former Vice President of Research, Google
Tan Chorh CHUAN,
President, National University of Singapore;
Chair, Global University Leaders Forum for the
World Economic Forum
Suzanne WALSH,
Deputy Director, Postsecondary Success,
Bill & Melinda Gates Foundation
Carl WIEMAN,
Nobel Laureate and Professor of Physics and
Education, Stanford University

The GLC was formed in conjunction with
the launch of the Simon Initiative at
Carnegie Mellon University.

Other Contributors

Norman BIER,
Director, Open Learning Initiative;
Executive Director, The Simon Initiative,
Carnegie Mellon University
Justine CASSELL,
Associate Vice-Provost for Technology Strategy
and Impact; Human-Computer Interaction,
Carnegie Mellon University
Meaghan DUFF,
Executive Director, Personalized Learning
Consortium, Association of Public and
Land-grant Universities
Ken KOEDINGER,
Director, Pittsburgh Science of Learning Center;
Professor, Human-Computer Interaction and
Psychology, Carnegie Mellon University
Marsh Lovett,
Director, Eberly Center for Teaching
Excellence & Educational Innovation;
Teaching Professor, Department of Psychology,
Carnegie Mellon University
Rahim RAJAN,
Senior Program Officer, Postsecondary Success,
Bill & Melinda Gates Foundation
Bror Saxberg,
Chief Learning Officer, Kaplan Inc.
Michael Tanner,
Chief Academic Officer and Vice President,
Association of Public and Land-grant
Universities

The GLC is grateful to the Carnegie Corporation of New York for partial support of its efforts through a grant to Carnegie Mellon University.