Literature Review of Practical Insights into the Use of Brain Science and Learning Technology to Enhance STEM Student Learning –

Laying the Foundation for Action

Professor Keith Schimmel

Department of Engineering

OLIVET NAZARENE UNIVERSITY

Adopting ChatGPT In Colleges May Influence Educator's Jobs, Research Suggests

CNBC (4/2/23, Chun) reports that as the adoption of ChatGPT threatens education, recent research from professors at the University of Pennsylvania's Wharton School, Princeton, and New York University "suggests that educators should be just as worried about their own jobs." ***In an analysis of professions "most exposed" to the "latest advances in large language models like ChatGPT, eight of the top 10 are teaching positions.***" Post-secondary teachers in "English language and literature, foreign language, and history topped the list among educators." ***However, jobs most "exposed to AI" does not "necessarily mean the human positions will be replaced." Co-author Manav Raj said, "ChatGPT can be used to help professors generate syllabi or to recommend readings that are relevant to a given topic. ChatGPT can even help educators translate some of those lessons or takeaways in simpler language."***

Professors Face Questions On How ChatGPT May Impact Student Learning Assessments

The Chronicle of Higher Education (4/5/23, Supiano) reports many professors are excited by ChatGPT's "potential to enhance learning, and perhaps provide needed support to students who start at a disadvantage." But while there are "lots of ways students could use ChatGPT without having it do their work for them, like using it to brainstorm ideas or offer clearer definition of something they're trying to understand," many professors are apprehensive. Will the "advent of these generative artificial-intelligence systems force faculty members to change the way they assess student learning all over again?" For instance, professors "provide two kinds of assessment, summative and formative." Formative assessment, "like the comments professors leave on the draft of a paper or a quiz meant to check students' understanding, is feedback meant to support learning by letting students know what they need to work on." ***If students hand in assignments "completed by ChatGPT, then those assignments can't give professors the information they need about students' learning***."

AI Experts Say 40% Of Domestic Tasks, Including Caregiving, Could Be Automated In A Decade

Fox Business (4/12/23, Revell) reports researchers "from Ochanomizu University and the University of Oxford surveyed 65 AI experts from Japan and the U.K. about how automatable a variety of domestic tasks – cooking, grocery shopping, laundry and caregiving – will be over the next five to 10 years." Grocery shopping and other shopping "were the activities viewed as most automatable in the next five to 10 years by AI experts surveyed." Meanwhile, caregiving for adults "was viewed as automatable by nearly 24% of experts in the next five years and just under 35% in 10 years."

Oxford Philosopher Offers Thoughts On AI Sentience

In an interview with the New York Times (4/12/23), Nick Bostrom, a philosopher at Oxford University, discussed the prospect of AI sentience. In his opinion, "sentience is a matter of degree," and some AI may "plausibly be candidates for having some degrees of sentience." Bostrom said, "***If an A.I. showed signs of sentience, it plausibly would have some degree of moral status. This means there would be certain ways of treating it that would be wrong.***"

New Research Estimates OpenAI's ChatGPT Uses 500ml Of Water For Every 20 To 50 Questions Answered

Insider (4/14/23, Gendron) reported researchers at the University of California, Riverside and the University of Texas, Arlington released a new study which analyzes "the water footprint of AI models like OpenAI's GPT-3 and GPT-4." In the process of "training GPT-3 in its data centers, Microsoft was estimated to have used 700,000 liters – or about 185,000 gallons – of fresh water." These figures suggest "that ChatGPT would require 500 ml of water, or a standard 16.9 oz water bottle, for every 20 to 50 questions answered."

ChatGPT and the Rise of AI

Professor Derek Schuurman – ELEN Calvin University

- Avoid pitfalls of viewing technology with too much optimism or pessimism.
- Rather than focusing on what AI can do, start with ontological question: How are people distinct from machines?
- We need to discern norms for the responsible use of AI, appropriate norms should point us towards using AI to opening up new possibilities for showing love to our neighbor and caring for the earth and its creatures.
- ***Colleagues at Calvin University has been exploring the use of AI for helping people write better (as opposed to writing for them).***

OLIVET NAZARENE UNIVERSITY

Why Might ONU Engineering Dept. Not be Sustainable?

- **Sustainable ≡ maintenance of enrollment, retention, graduation rates, job placement, diversity, and faith integration to be financially viable and ONU mission focused**
- **Drivers for Value/cost Not Being Competitive:**

(1) More than half of Americans don't believe a college degree is worth the money anymore

(2) Quality of education is not better than less expensive alternatives that utilize technology and scale

(3) Not agile enough to keep pace with technological advances in engineering education to produce student product employers desire

(4) Decreased student demand due to demographics of college age population desiring a Christian college education (National trends worse in Midwest)

(5) Poor U.S. economic outlook

OLIVET
NAZARENE UNIVERSITY

Premises and Motivating Question

- ***Premise 1:*** *If applied technology is to be used to make a programs more sustainable,* ***engineering departments*** *should be a leader in this.*
- ***Premise 2:*** *If cooperation among department faculty is needed to make a program more sustainable,* ***Christian universities*** *should be a leader in this.*
- ***Motivating Question:*** *What are the possibilities for change to make the ONU engineering department sustainable?*

OLIVET
NAZARENE UNIVERSITY

Grand Canyon University (GCU) – Example of use of Technology to Achieve Sustainability

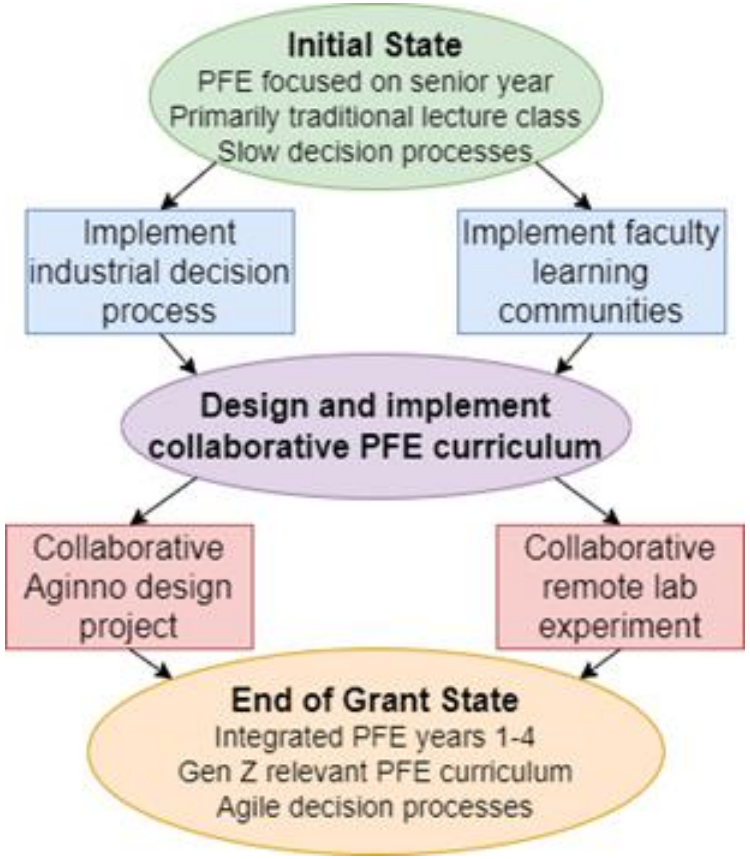
- Private non-denominational Christian college in Phoenix, Arizona, founded in 1949.
- Grown from 1,000 on-campus students in 2008 to 25,350 in 2022, online enrollment also doubled in the last decade.
- Addition of new degree programs driven by job opportunities, includes STEM.
- ***Costs kept low by employing a small staff to serve both in person and online students – possible through use of technology***, average GCU student $9,200 in tuition before scholarships, average debt level for graduates $21,557.
- University launched several local businesses that generate jobs for students and residents.

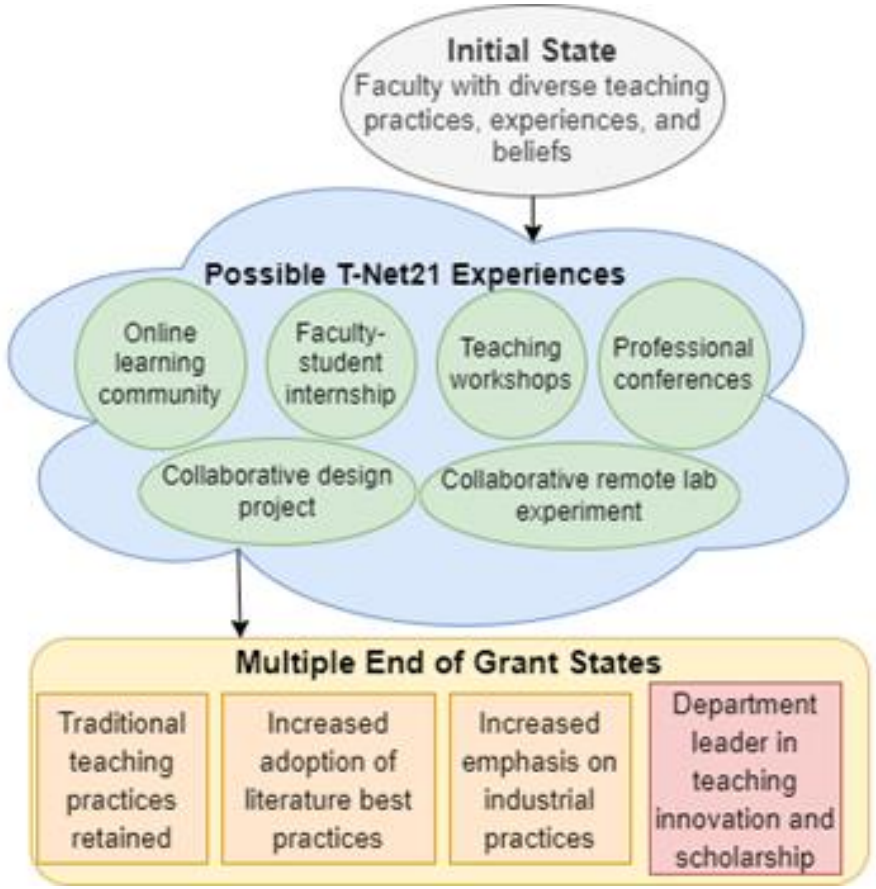
NSF Revolutionizing Engineering Departments (RED) Proposal: A Model of Change for Enabling Convergence through an Institutional Network Developing T-shaped 21st Century Skills (T-Net21)

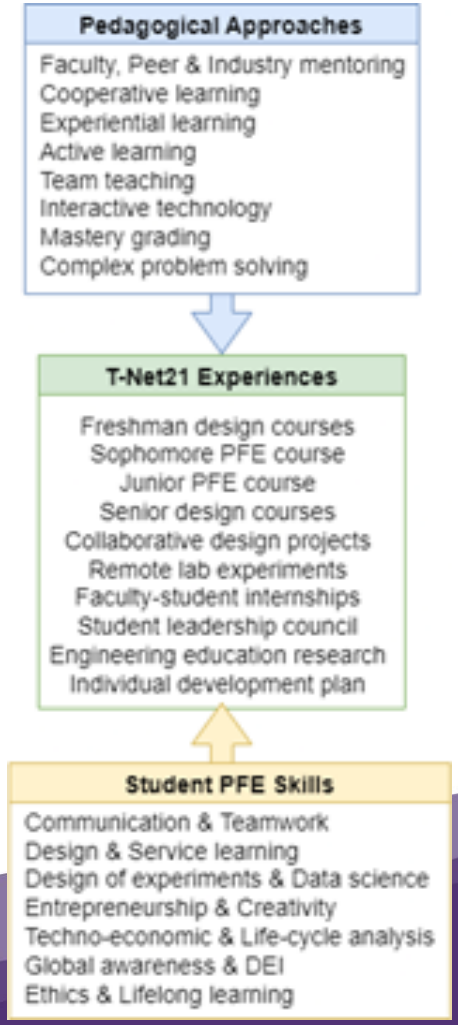
- **Vision:** A network of ***three liberal arts universities with ABET accredited general engineering departments (ONU, MVNU, NNU)*** will collaborate to develop a middle years Professional Formation of Engineers (PFE) curriculum for Gen Z students that is structured to facilitate ***team teaching of a thread of PFE courses across eight network universities and adoption/adaptation to other universities***.

OLIVET NAZARENE UNIVERSITY

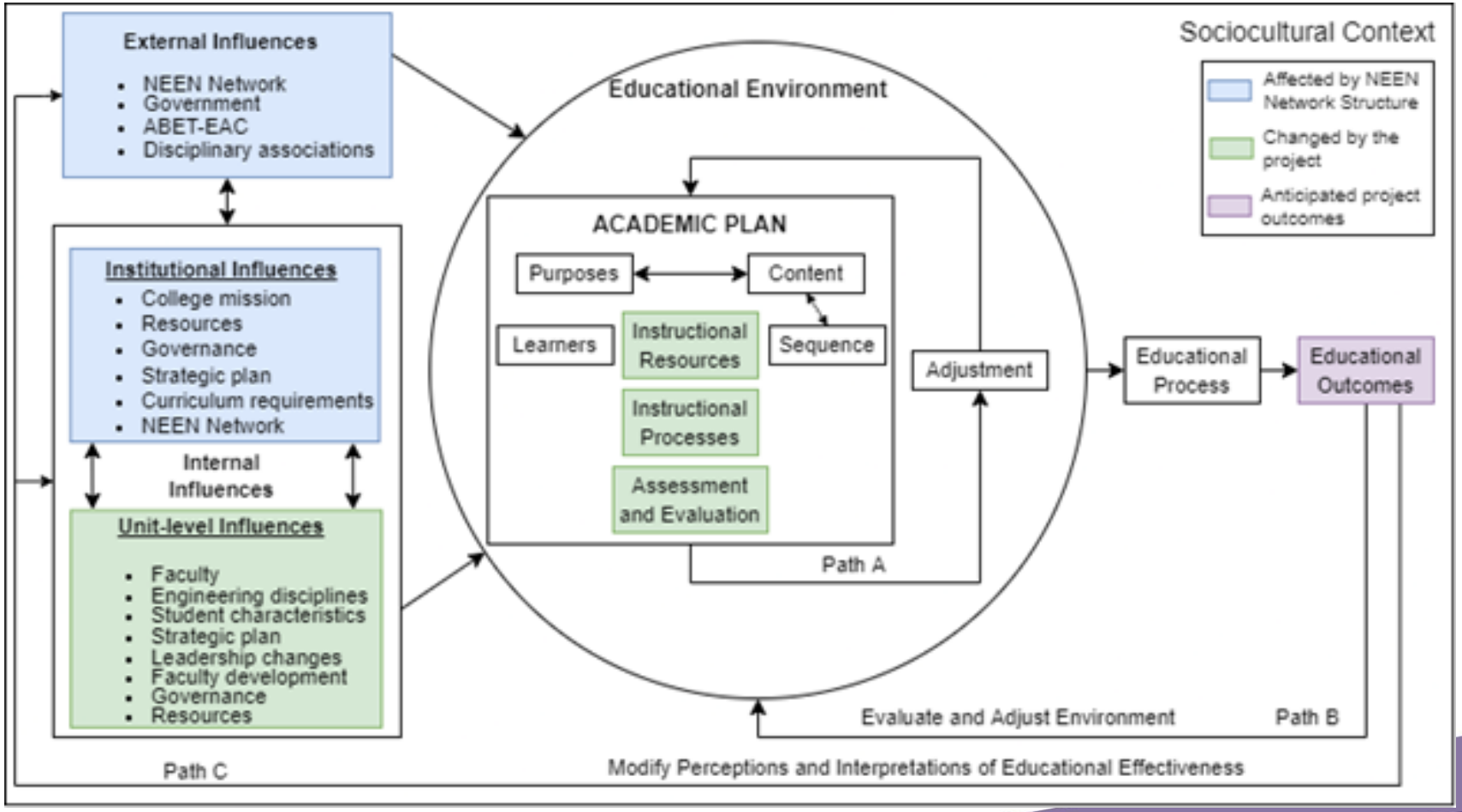
Summary of the "Revolution" in terms of (a) department, (b) faculty, and (c) student Impact



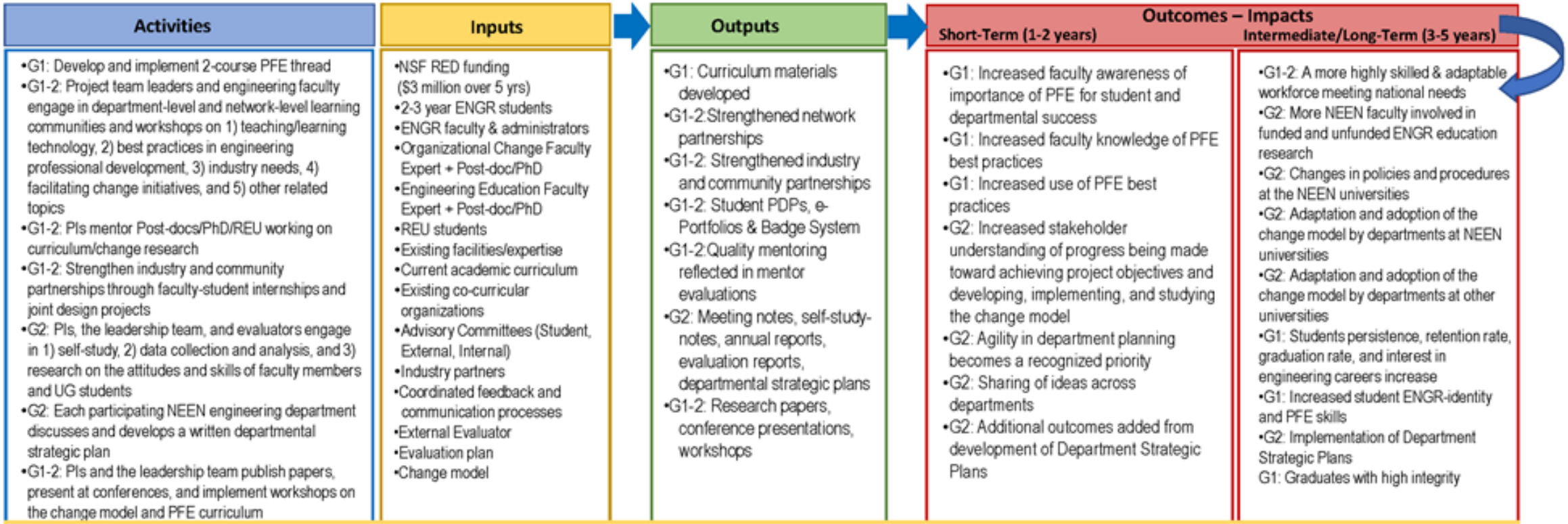




Academic Plan Model



T-Net21 Logic Model



Intellectual Merit: Increased Understanding of Diffusion of Engineering Education Innovations

- ***Faculty development activity*** to bridge the engineering education research-to-practice gap through ***online faculty PFE skills learning communities***:

(1) Communication & Teamwork

(2) Design & Service Learning

(3) Design of Experiments & Data Science

(4) Entrepreneurship & Creativity

(5) Professional Ethics & Lifelong Learning

(6) Global Awareness, Diversity, Equity & Inclusion

Learning Research-based Elements of the T-Net21 Courses

(1) Focus on design and innovation approaches with ***interdisciplinary, open-ended problem-solving skills*** instead of traditional closed-ended math and science problems

(2) Emphasis on ***active learning approaches*** shown to be successful with Gen Z students

(3) Use of educational technologies that leverage mobile computing and learning analytics to enable formal and informal learning, e.g. development and use of a ***remote experimental setup shared among all three universities***

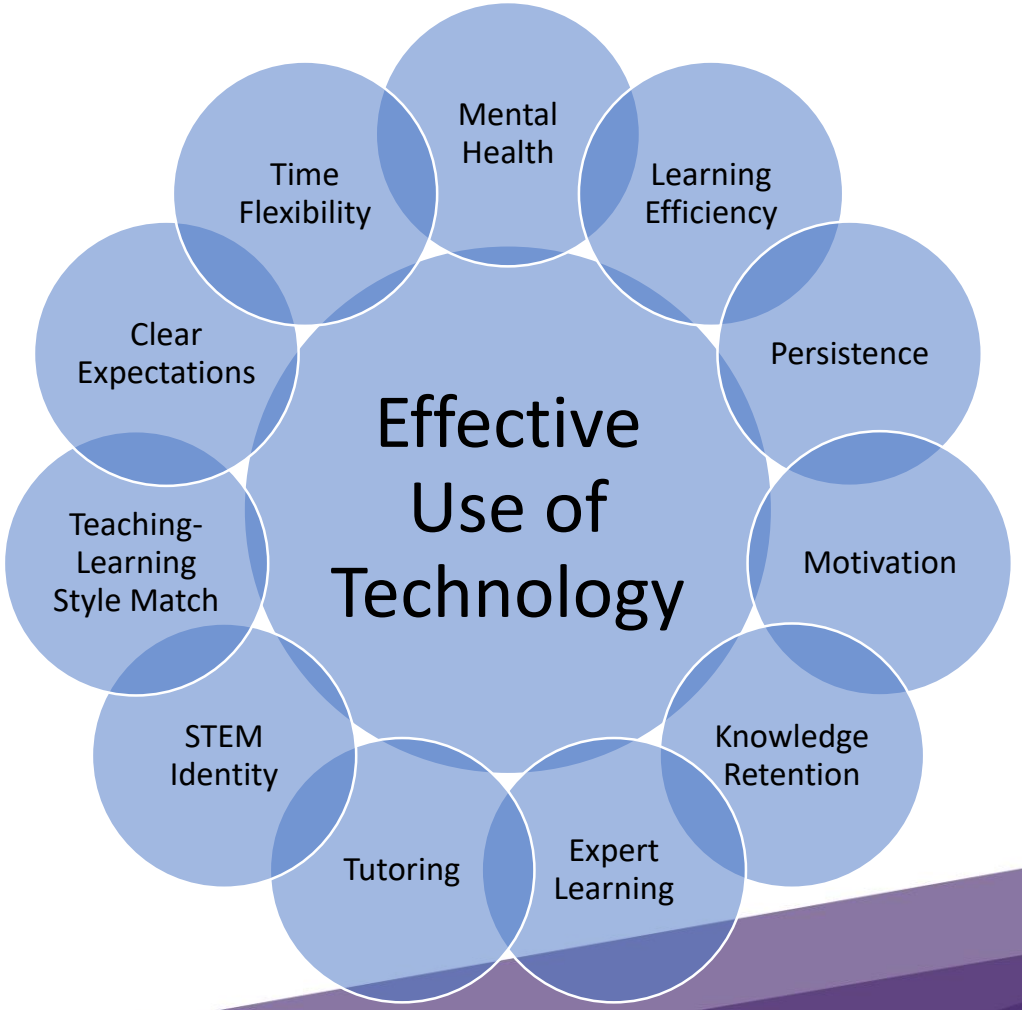
(4) ***Individualized elements to meet the needs of 2+2 students and other diverse student pathways***

(5) ***Team taught leveraging faculty skills and expertise from across the network***

(6) ***Collaborative assignments*** requiring students from multiple universities to use a variety of technologies to complete

(7) Use of ***mastery-based assessment***

Student Keys to Success that can be Addressed by Effective Use of Technology



Challenges to Institutional Change

Kezar & Eckel (2002) **model for change** built upon five core strategies for institutional transformation:

1) Shared leadership

2) Senior administrative support

3) Robust (flexible) design

4) Faculty development

5) Visible action

Survey of Climate for Instructional Improvement (SCII)

Charles Henderson, Center for Research on Instructional Change in Postsecondary Education, Western Michigan University

SCII Factors	Collegiality	Leadership	Org. Support	Resources	Teaching Respect
Un. 1 (n=3)	80.0 (5.0 s.d.)	88.7 (5.7 s.d.)	70.0 (5.9 s.d.)	70.7 (4.9 s.d.)	82.0 (8.3 s.d.)
Un. 2 (n=6)	90.7 (1.2 s.d.)	89.0 (3.0 s.d.)	55.8 (2.9 s.d.)	77.7 (3.8 s.d.)	85.5 (2.4 s.d.)
Un. 3 (n=3)	61.3 (2.9 s.d.)	71.0 (0.8 s.d.)	41.7 (1.6 s.d.)	58.0 (6.6 s.d.)	72.0 (3.1 s.d.)
Average	77.3	82.9	55.8	68.8	79.8

70-75% Considered Favorable Climate

Conclusion: Opportunity and Challenge

- Case studies suggest a more sustainable engineering department is possible at ONU (e.g., Grand Canyon University).
- Program emphasis should be driven by job market opportunities (e.g., pharmaceutical – International Society of Pharmaceutical Engineers (ISPE)), which provide opportunity to launch local businesses that generate jobs for students.
- Technology needs to be used to keep costs down and provide flexibility in delivery modes.
- ***New opportunity is to be leader in applying the science of how people learn with technology.***
- **Taking advantage of this opportunity requires overcoming institutional barriers to change: Shared leadership, Senior administrative support, Robust (flexible) design, Faculty development, Visible action.**

Additional References of Interest

- N. W. Gleason, Ed., Higher Education in the Era of the Fourth Industrial Revolution. Springer Nature, 2018. doi: 10.1007/978-981-13-0194-0.
- K. G. Fomunyam, “Education and the Fourth Industrial Revolution: Challenges and possibilities for engineering education,” Int. J. Mech. Eng. Technol., vol. 10, no. 08, pp. 271–284, 2019.