

Entrepreneurship Mindset in Undergraduate Engineering Education Theoretical and Practical Aspects

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Presentation Outline

- The Information Age & Requisite Skills
- Entrepreneurship: an Educational Platform?
- Entrepreneurship & Entrepreneur
- Entrepreneurially Minded Engineer
- Metacognitive Model of the Entrepreneurial Mindset
- Entrepreneurship Program Models
- Recent Trends in Entrepreneurial Activity
- Attributes of an Entrepreneurial Engineer
- KEEN's 3 C's of Entrepreneurial Mindset
- Building an Entrepreneurial Mindset at UNH
- Curricular Activities
- The Flipped Classroom Instructional Model
- Integration of e-Learning Modules
- Module Content Curriculum Integration
- Assessment of Entrepreneurial Mindset



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Our Era: The Information Age



- Globalization
- Increasing importance of information
- Use of information to increase productivity
- Increasing proportion of “knowledge workers”
- Innovation transforming processes
- Networked economies and societies
- Constantly changing images and messages



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Information Age Demands Engineers with Set of Diverse Skills



Content
Knowledge



Learning &
Innovation
Skills



Information
& Media
Technology
Skills



Life &
Career
Skills



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Content-related Literacy

Content Knowledge

Disciplinary

Interdisciplinary

Language Arts

Arts

Mathematics

Natural
Sciences

Economics

Social
Sciences

Global
Awareness

Business &
Entrepreneurial
Literacy

Civic
Literacy

Health
Literacy

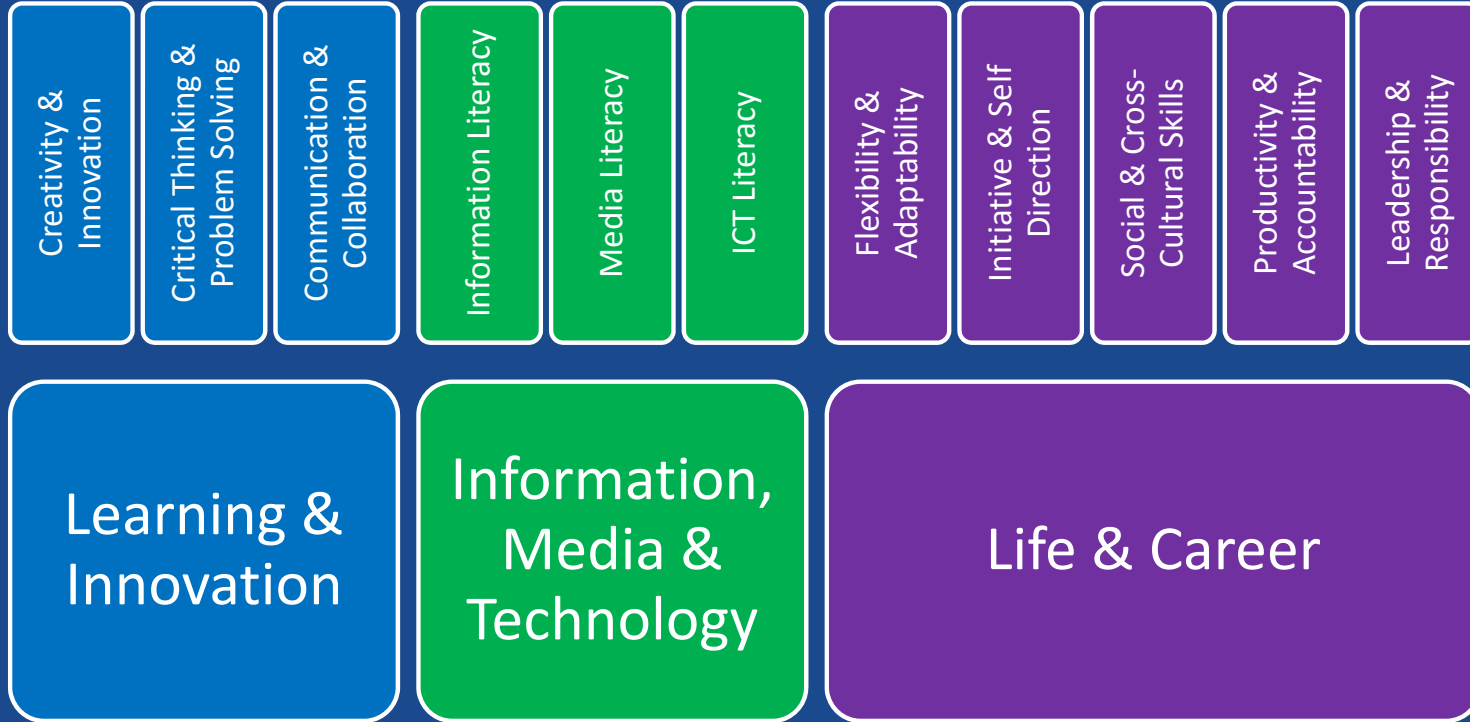
Environmental
Literacy



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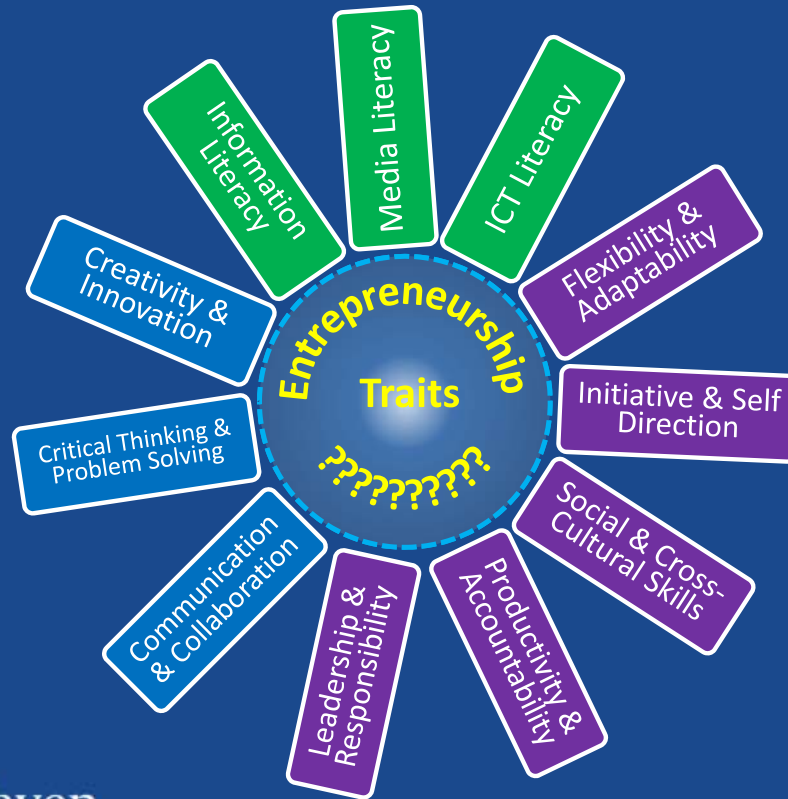
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Additional Skills



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Entrepreneurship an Educational Platform for Attaining Additional Skills?



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Entrepreneurship & Entrepreneur

- Entrepreneur
 - A fully engaged thinker and motivated tactician, who has multiple cognitive strategies available, and chooses among them based on goals, motives, and needs

Entrepreneurship

en-tre-pre-neur-ship, noun:

Self-employment through business ownership which has significant elements of risk, control and reward.



John Hughes
Chairman Emeritus, Coleman Foundation



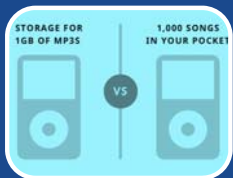
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Fiske, S., Taylor, S., 1991. Social cognition, 2nd ed. McGraw-Hill Book Company, New York, NY

Entrepreneurially Minded Engineer

Entrepreneurially Minded Engineer = an engineer instilled with the entrepreneurial mindset



Places product benefits before design features



Leverages technology to fill unmet customer needs.

Kriewall, T. J., & Mekemson, K. (2010). Instilling the Entrepreneurial Mindset Into Engineering. *The Journal of Engineering Entrepreneurship*, 1(1), 5-19.

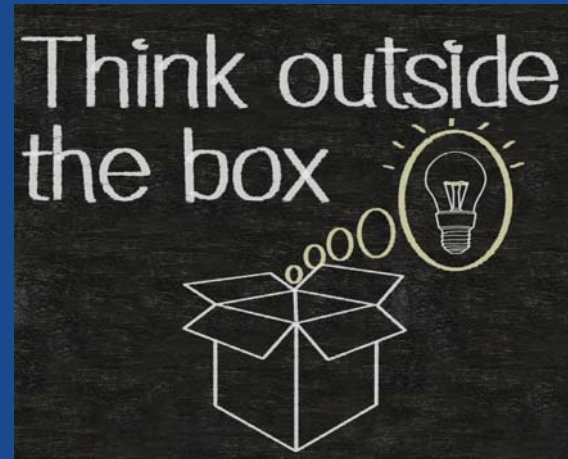


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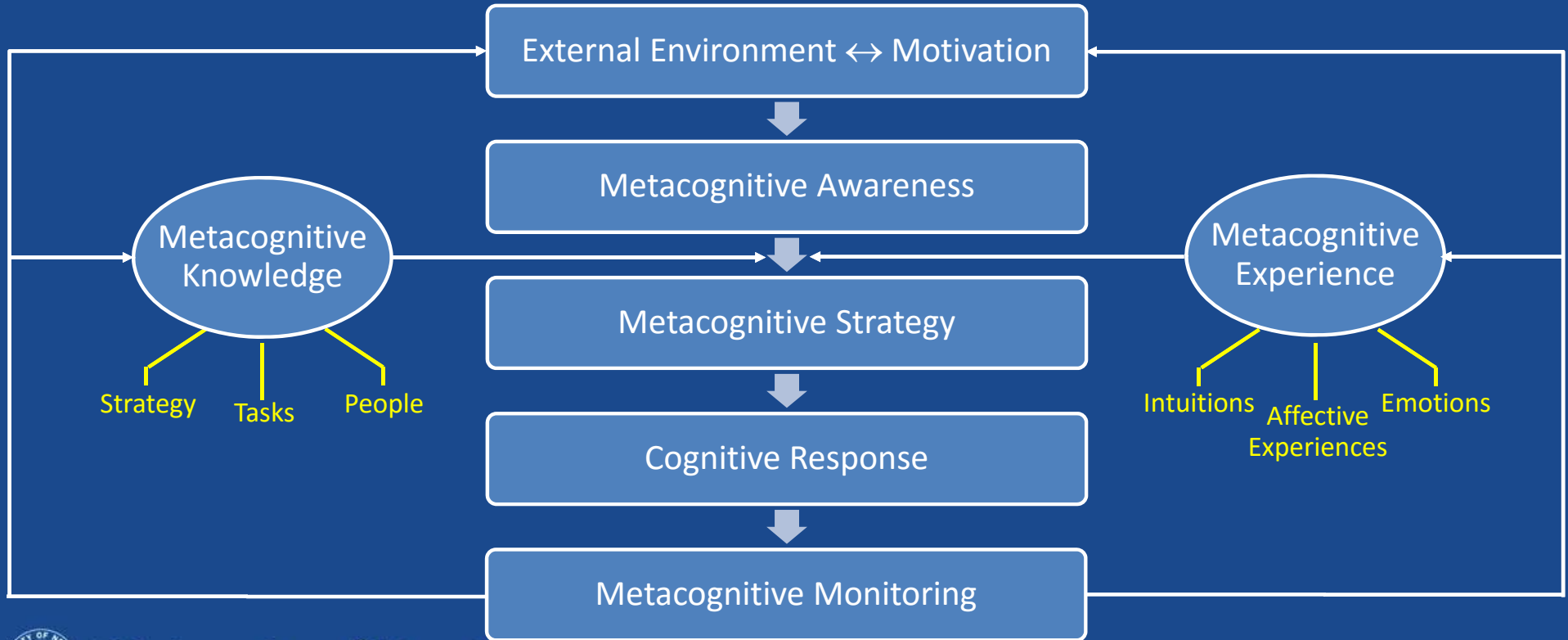
Entrepreneurial Mindset

- The ability to sense, act, and mobilize under uncertain conditions



Haynie, J. M., Shepherd, D., Mosakowski, E., & Earley, P. C. (2010). A situated metacognitive model of the entrepreneurial mindset. *Journal of Business Venturing*, 25(2), 217-229.
<https://doi.org/10.1016/j.jbusvent.2008.10.001>

Metacognitive Model of the Entrepreneurial Mindset



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Haynie, J. M., Shepherd, D., Mosakowski, E., & Earley, P. C. (2010). A situated metacognitive model of the entrepreneurial mindset. *Journal of Business Venturing*, 25(2), 217-229. <https://doi.org/10.1016/j.jbusvent.2008.10.001>

Engineering Entrepreneurship Program Models in the U.S.

Business School

- Formal technology entrepreneurship curriculum developed through collaboration with engineering or science or courses serving engineering/science students

Engineering School

- Formal technological entrepreneurship curricula that co-exist with curricula offered by the business school

Multi-School

- Formal technological entrepreneurship curriculum developed with active collaboration of a business school and one or more technical schools



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Standish-Kuon, T., & Rice, M. P. (2002). Introducing engineering and science students to entrepreneurship: Models and influential factors at six American universities. *Journal of Engineering Education*, 91(1), 33-39.

Features of Entrepreneurship Educational Programs



Character of Entrepreneurship Programs

- Non-traditional interdisciplinary programs
- Administered/funded/delivered by multiple academic units or centers



Teaching/Administrative Human Resources

- Rely predominantly on non-tenure track faculty or practitioners



Institutional Culture

- Extent to which entrepreneurship is valued and encouraged
- Infrastructure for intellectual property, technology transfer, and business incubation
- Support for academic programs by stakeholders



Entrepreneurial Ecosystem

- Mentors, internships, other experiential opportunities
- Funding
- Talent necessary to start and grow new ventures



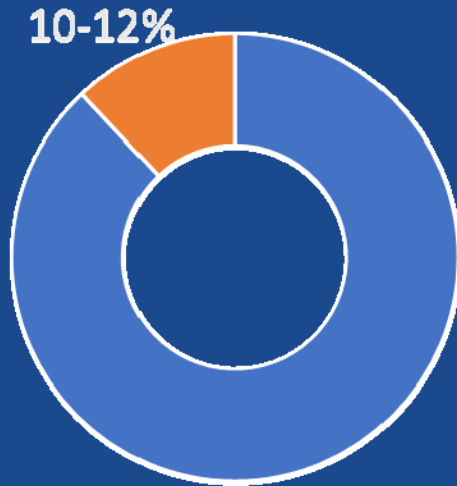
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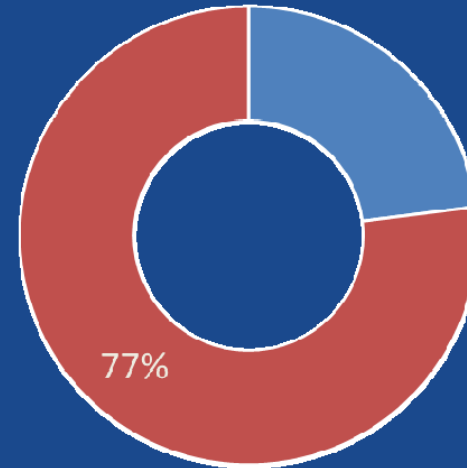
Duval-Couetil, N., Shartrand, A., & Reed, T. (2016). The role of entrepreneurship program models and experiential activities on engineering student outcomes. *Advances in Engineering Education*, 5(1), 1-27.

Recent Trends in Entrepreneurial Activity

U.S. Population Engaged in Entrepreneurial Activity



U.S. Students (grades 5-12) Interested In Starting a Business



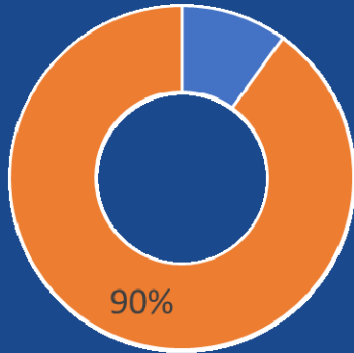
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Rideout, E. C., & Gray, D. O. (2013). Does entrepreneurship education really work? A review and methodological critique of the empirical literature on the effects of university-based entrepreneurship education. *Journal of Small Business Management*, 51(3), 329-351.

Recent Trends in Entrepreneurship Education

**% of 888 accredited M.S. and Ph.D. granting
Institutions offering entrepreneurship
courses/degrees**



Cone, J. (2000). *Entrepreneurship on Campus: Why the Real Mission Is Culture Change*. Kauffman Thoughtbook. Kansas City: Ewing Marion Kauffman Foundation, 78–86

- 400,000: Students enrolled in E-courses
- 2,200: E-courses available
- >1,600: Institutions nationwide
- 277: Endowed faculty positions
- 44: Academic journals
- ~150 Research centers

Finkle, T. A., Kuratko, D. F., & Goldsby, M. G. (2006). An examination of entrepreneurship centers in the United States: A national survey. *Journal of Small Business Management*, 44(2), 184-206. <https://doi.org/10.1111/j.1540-627X.2006.00163.x>



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Attributes of an Entrepreneurial Engineer

- Curiosity
- Integrity
- Tenacity
- Ethics
- Creativity
- Intuition
- Knowledge of engineering fundamentals
- Ability to engineer products for commercialization
- Inclination for lifelong learning
- Ability to see how his/her ideas fit into the larger context of society
- Proficiency in communicating his or her ideas



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Kriewall, T. J., & Mekemson, K. (2010). Instilling the Entrepreneurial Mindset Into Engineering. *The Journal Of engineering entrepreneurship*, 1(1), 5-19.

KEEN's 3 C's of Entrepreneurial Mindset

Curiosity

- Demonstrate constant curiosity about our changing world
- Explore a contrarian view of accepted solutions

Connections

- Integrate information from many resources to gain an insight
- Assess and manage risk

Creating value

- Identify unexpected opportunities to create extraordinary value
- Persist through and learn from failure



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The Kern Entrepreneurial Engineering Network (KEEN)

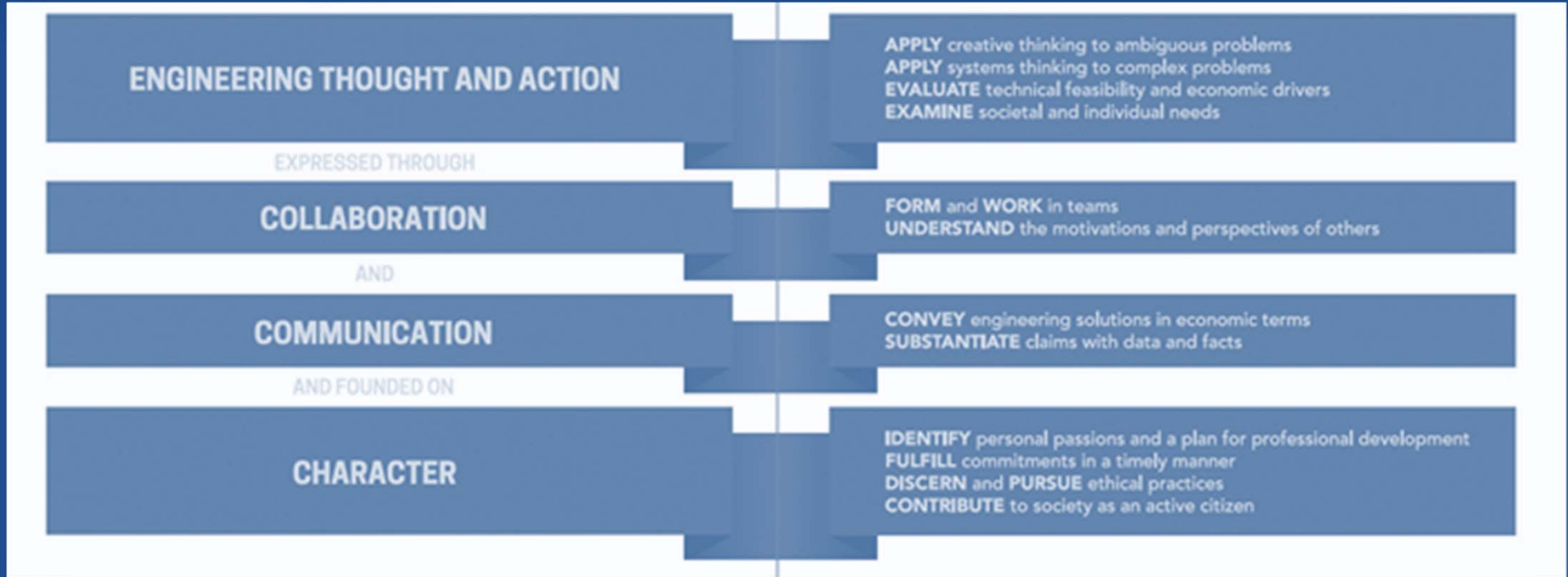
- **What is KEEN?**
 - “A collaboration of U.S. universities that strive to instill an entrepreneurial mindset in undergraduate engineering and technology students.”
- **KEEN’s Mission**
 - “To graduate engineers with an entrepreneurial mindset so they can create personal, economic, and societal value through a lifetime of meaningful work”
- **KEEN Learning Outcomes**
 - 12 outcomes grouped in 4 categories
 - Engineering thought and action (4)
 - Collaboration (2)
 - Communication (2)
 - Character (4)



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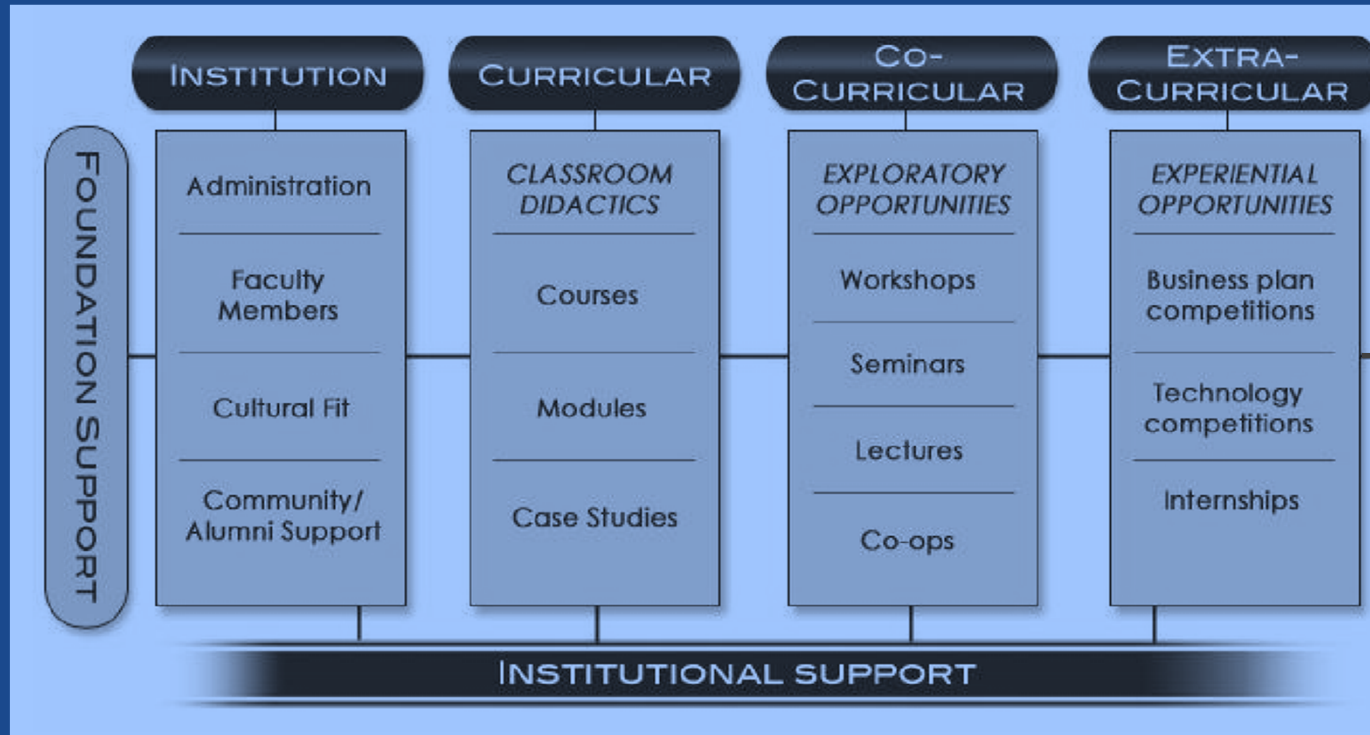
The 12 KEEN Learning Outcomes



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<https://www.newhaven.edu/engineering/kern-entrepreneurial-engineering-network/elearning-modules/student-outcomes.php>

The KEEN Model



ENTREPRENEURIAL MINDSET



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Kriewall, T. J., & Mekemson, K. (2010). Instilling the Entrepreneurial Mindset Into Engineering. *The Journal Of engineering entrepreneurship*, 1(1), 5-19.

Developing an Entrepreneurial Mindset at UNH:

Four-faceted approach



Faculty

Developing an entrepreneurial mindset amongst faculty



Curricular

Providing all the components that advance specific student knowledge and skills



Environment

Structuring the physical environment to promote entrepreneurial minded learning



Extra-curricular

Offering opportunities for students to engage in meaningful extra-curricular activities

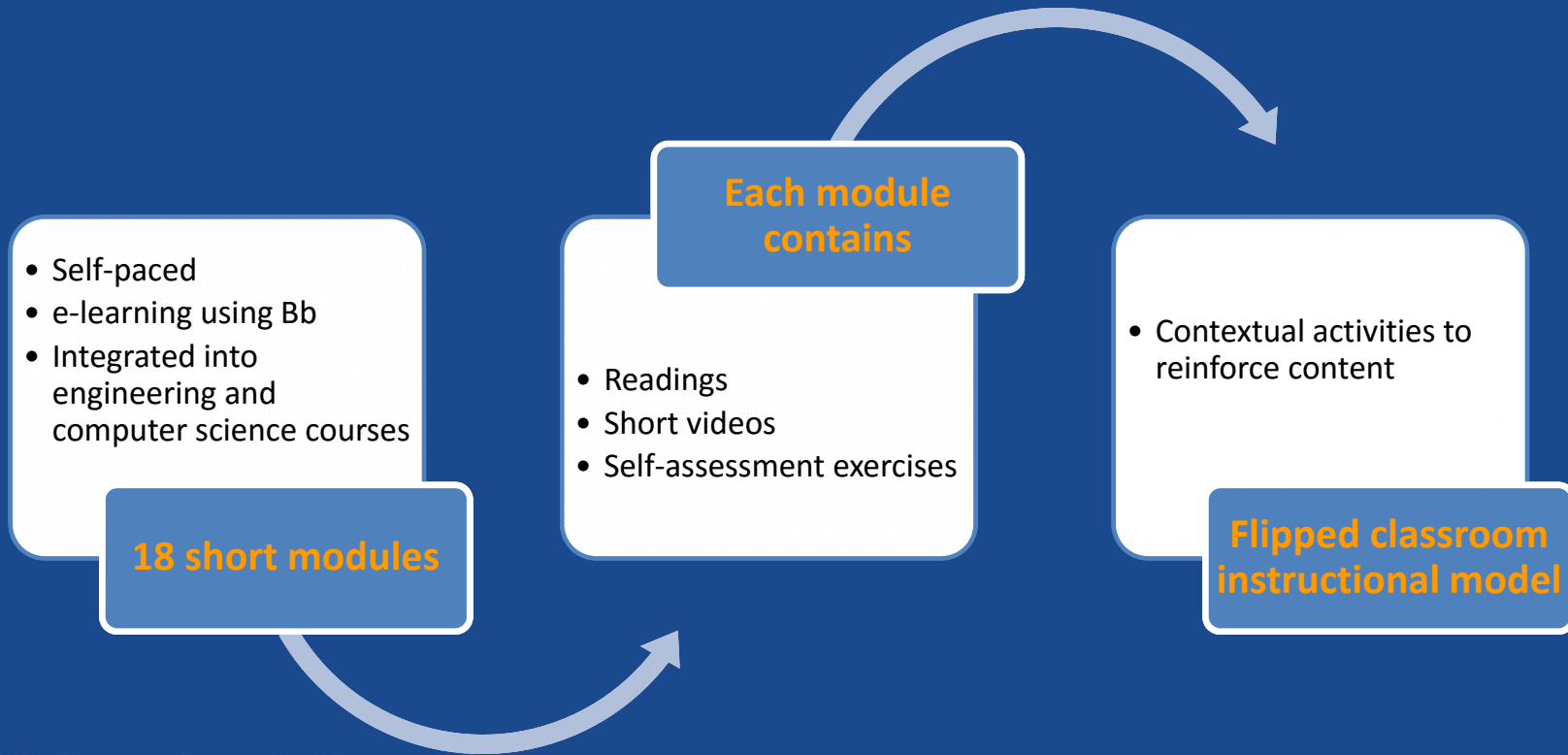


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Erdil, N. O., Harichandran, R. S., Nocito-Gobel, J., Carnasciali, M. I., & Li, C. Q. (2016). Integrating e-learning modules into engineering courses to develop an entrepreneurial mindset in students, 2016-June.

Curricular Activities Infusing an Entrepreneurial Mindset



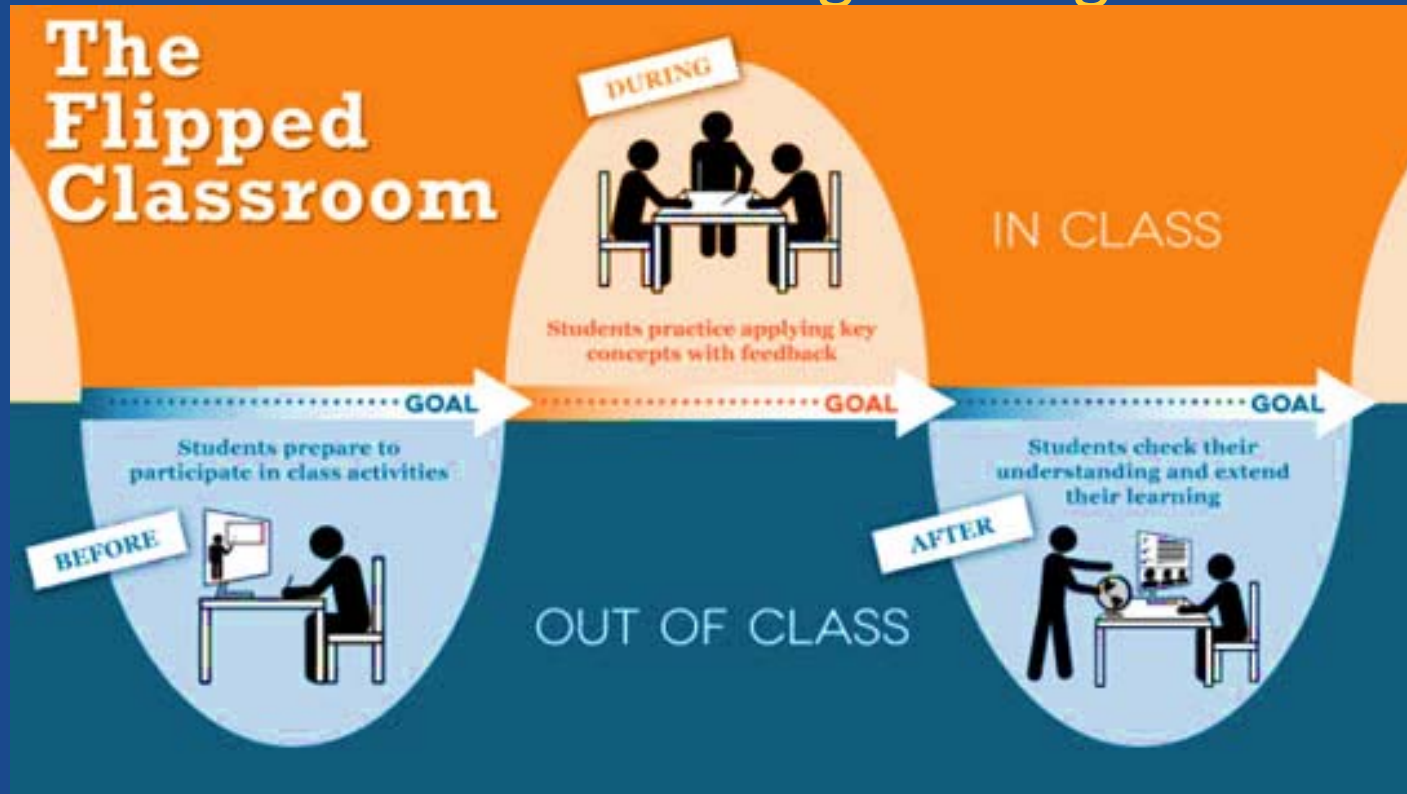
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The Flipped Classroom Instructional Model

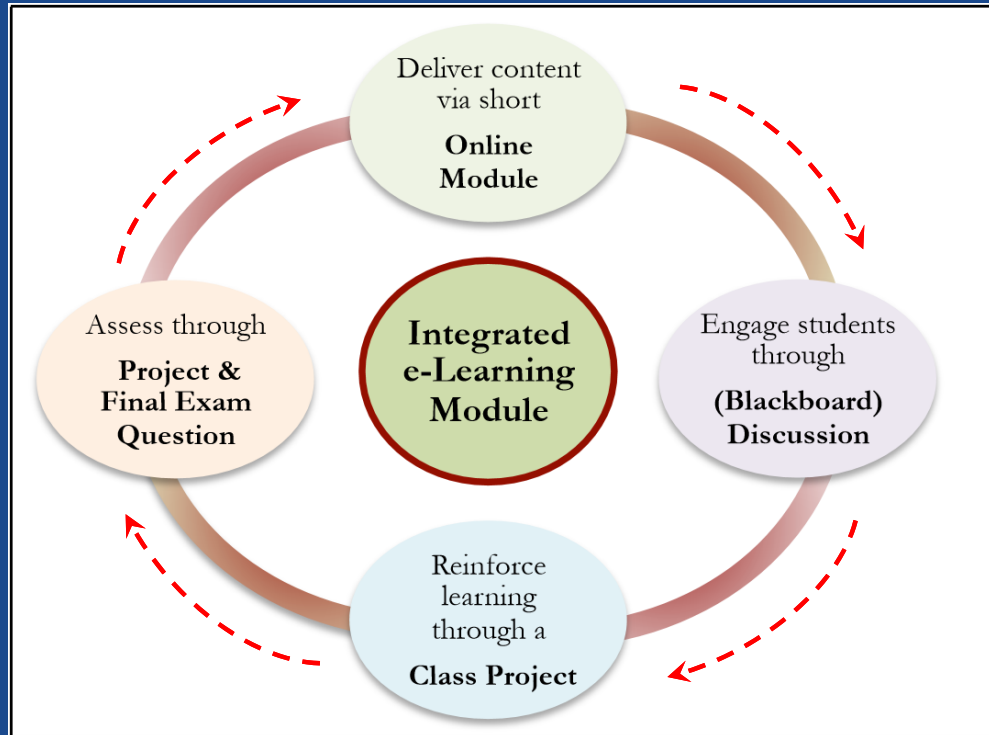
An Active Learning Paradigm



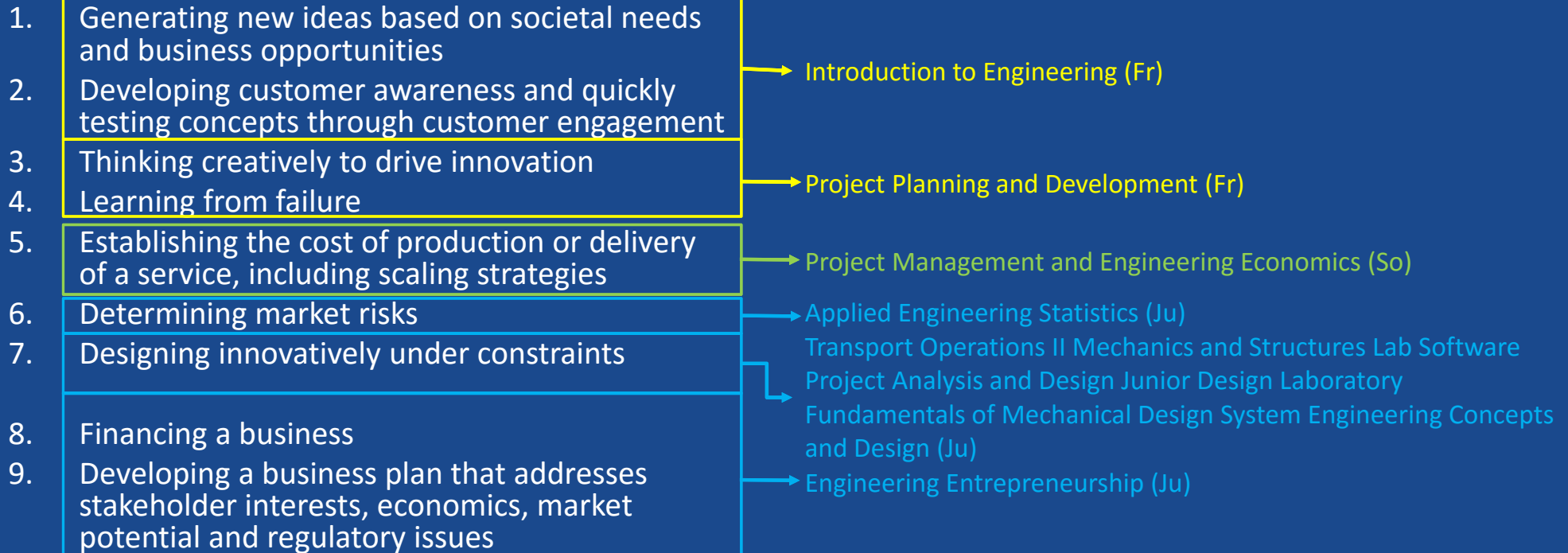
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Image Source: <http://thesecondprinciple.com/wp-content/uploads/2015/05/flipped-ms.jpg>

Integration Components of e-Learning Modules



Module Content Curriculum Integration 1/2



Module Content Curriculum Integration 2/2

- | | |
|---|--|
| 10. Marketing a product or service | → Engineering Entrepreneurship (Ju) |
| 11. Adapting a business to a changing climate | → Disciplinary Senior Design Courses |
| 12. Delivering an elevator pitch | → Disciplinary Senior Design Courses |
| 13. Resolving difficult ethical issues | → Professional Engineering Seminar Social & Professional Issues in Computing Professional and Ethical Practice (Ju) |
| 14. Building, sustaining and leading effective teams and establishing performance goals | → Chemical Engineering Laboratory Soil Mechanics Laboratory Junior Design Laboratory Mechanics Laboratory System Engineering Design Process (Ju) |
| 15. Building relationships with corporations and communities | → Mandatory internship |
| 16. Applying systems thinking to complex problems | → Disciplinary Senior Design Courses |
| 17. Recruiting and servicing clients | → Disciplinary Senior Design Courses |
| 18. Defining and protecting intellectual property | → Disciplinary Senior Design Courses |



Extra-curricular and Experiential Activities



Mandatory
Internships



Immersive
Experiences



Non-competitive

- 24-hr Imagination Quest and Start-Up Weekend
- 10-day KEEN Summer Interdisciplinary Design Experience
- 1-hr events (e.g. Engineering Challenges)
- Discussion Dinners for our Entrepreneurial Engineering Living/Learning Community

Competitive

- Intercollegiate regional/national competitions
- Senior design project competition



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Assessment of Entrepreneurial Mindset



An assessment instrument to measure the entrepreneurial mindset of engineering students has been developed

The questionnaire consists of two broad sets of items to measure:

- General entrepreneurial characteristics (curiosity level, personal experiences, and family influences)
- KEEN learning outcomes



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KEEN Universities



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Summary

✓ Entrepreneurship can be used as an educational platform for stimulating the development of valuable life and career skills for engineering students

✓ An entrepreneurial mindset is deep-rooted into the cognitive and metacognitive domains

✓ Entrepreneurship educational programs have flourished in recent years reflecting changes in society and global economy

✓ The UNH program for infusing an entrepreneurial mindset to engineering students is a modular approach (easily integrable to engineering curricula) combining:

- e-learning delivery methods
- The flipped classroom instructional model
- A variety of extra-curricular & experiential opportunities.



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