

EPICENTER  
**research summit**

AUGUST 4-5, 2014 • STANFORD UNIVERSITY

# Engineering Innovativeness

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**Stanford**  
University

NCIIA

# Research Question

**What are the knowledge, skills, and attributes that enable engineers to translate creative ideas into innovations that benefit society?**

This research is supported by the National Science Foundation's Engineering Education Program under Collaborative Grant 1264769 / 1264901.

# Years 1-5 of our research activity

NSF Project Timeline is years 3-5



# Characteristics of an Engineering Innovator

Alternatives Seeker

Analytical

Associative Thinker

Challenger

Collaborator

Communicator

Creative

Curious

Developer

Experimenter

Implementer

Knowledgeable

Leader

Market/Business Savvy

Passionate

Persistent

Risk Taker

Self-Reliant

User Empathetic

Visionary

# Confirming the Characteristic Findings

## Focus Group: Framework for Entrepreneurial Engineering

- 13 engineering entrepreneurs, engineering educators, and engineering innovators.
- 2 meetings, Stanford Sierra Camp-October, 2012;  
Atlanta, June 2013 at Georgia Tech

## Delphi Study

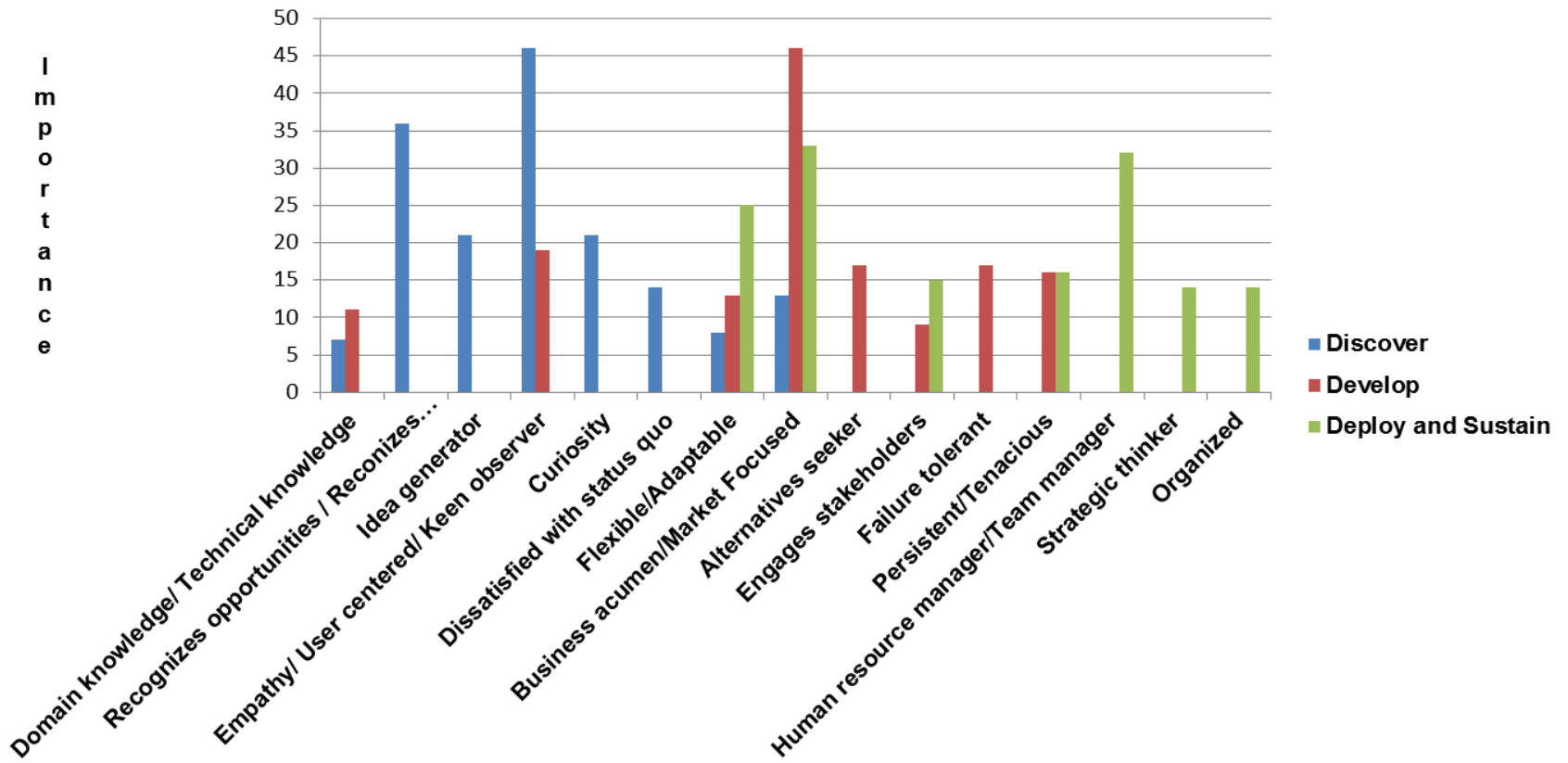
- 130 engineering innovators
- 3 rounds of anonymous information exchange

## Instrument Development and Testing

- Up to 2,000 test participants from each of two test populations, engineering students and practicing engineers
- Up to 20 collaborating organizations

# Focus Group Findings

Characteristics by Phase of Entrepreneurial Engineering



# Instrument Development Model\*

## Aspects of Design

### Substantive

- Determine theoretical framework

### Content

- Develop blueprint
- Consult content experts

### Generalizability

- Pilot test with diverse users

### Consequential

- Sensitivity review (bias/fairness)
- Expert content review
- Social consequences to society review

### Structural

- Reliability & factor analysis

### External

- Large-scale administration
- Compare with similar measures

\* Messick / Purzer & Cardella

# Research Collaborators, in addition to Penn State and Purdue

## Academic

Carnegie Mellon  
Georgia Tech  
Lawrence Tech  
Lehigh  
North Dakota State  
Rose-Hulman  
St Louis  
UC Berkeley

## Corporate

Kimberly Clark  
Procter & Gamble  
Schlumberger  
Walker Parking  
'Recruiting Companies'



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# Thank you!



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## A call for integrative and interactive models of student entrepreneurship development

Sarah E. Zappe  
*Penn State University*



Stanford  
University

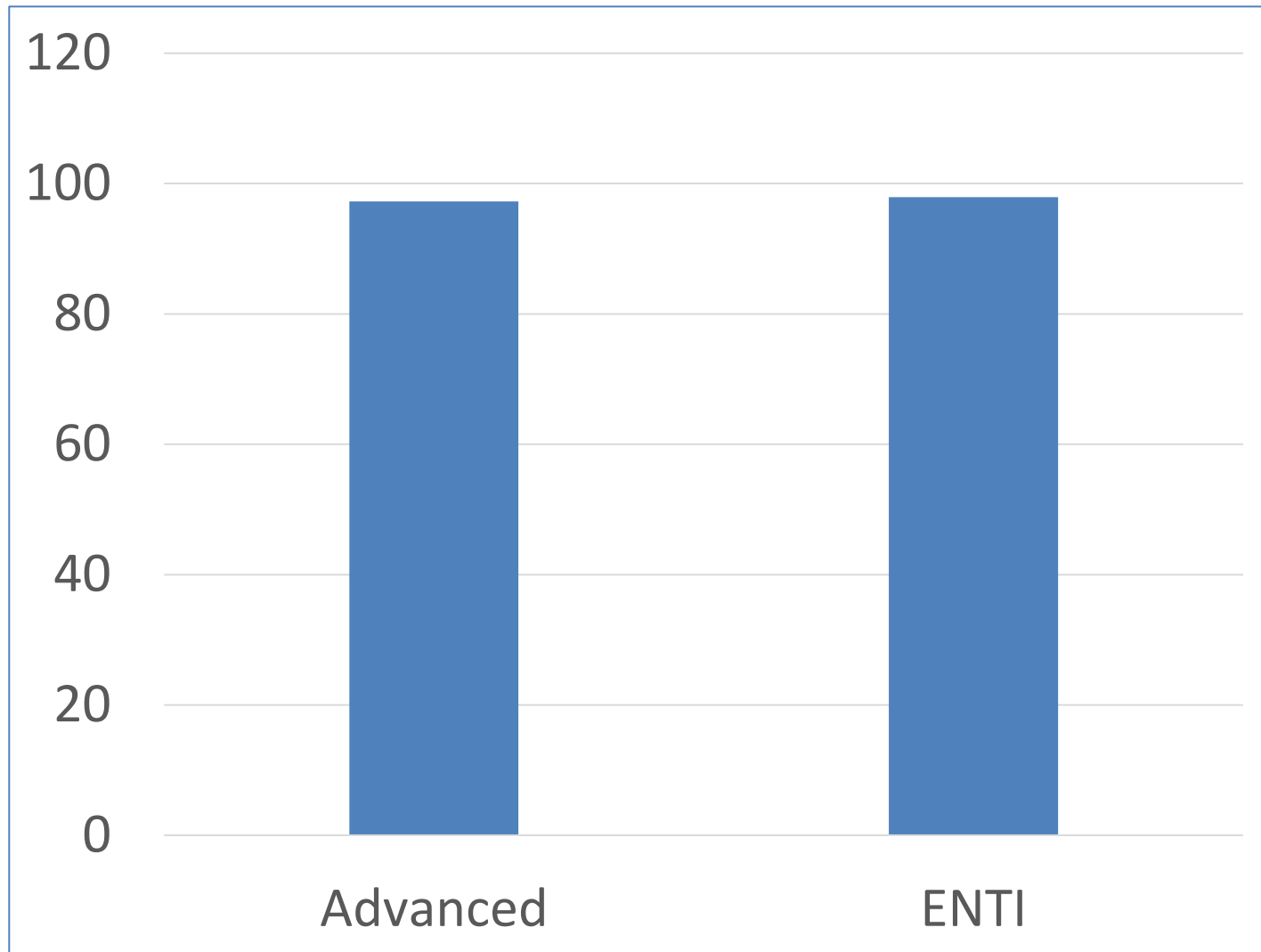
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# The theme of today's panel discussion is twofold:

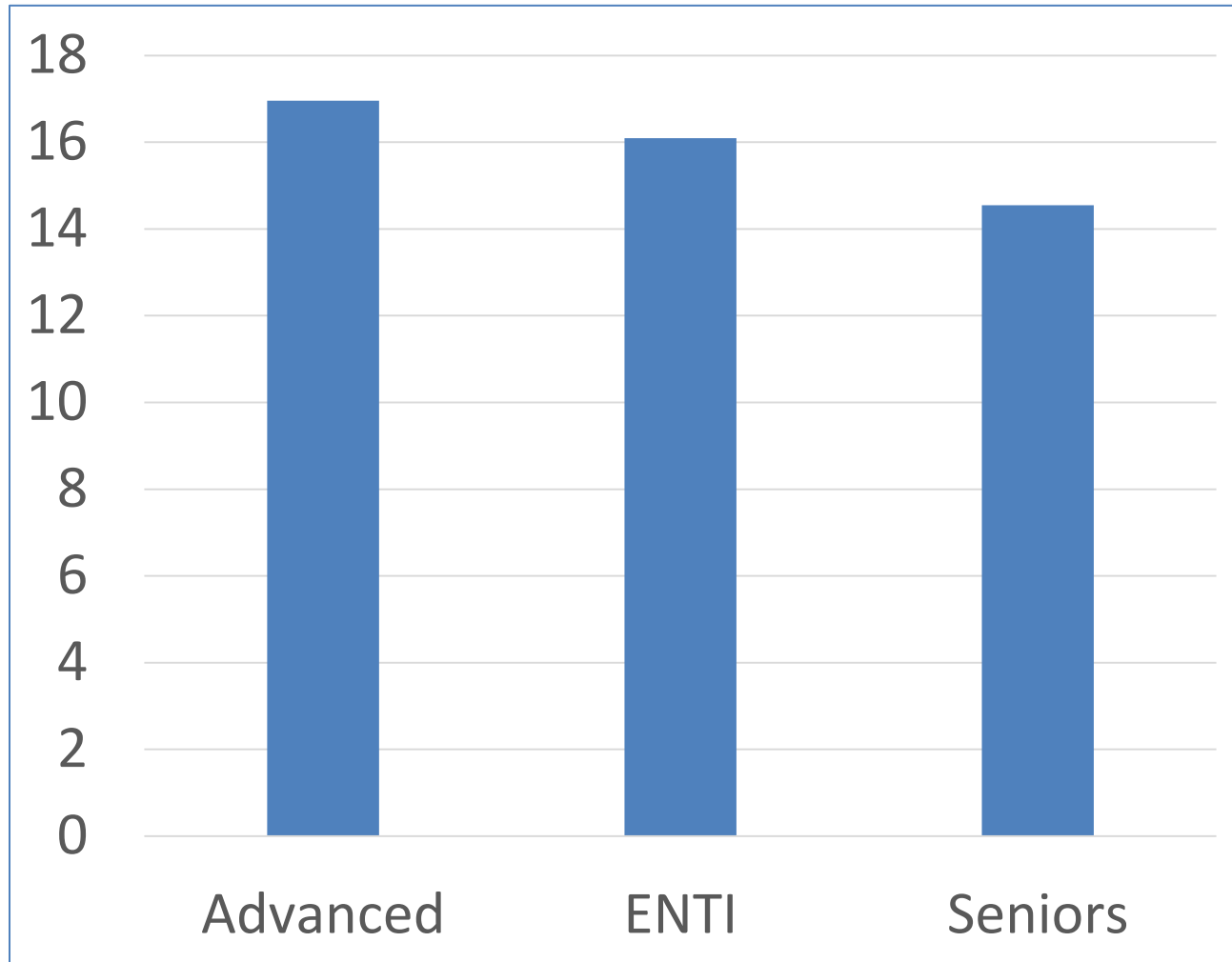
1. Interactive models of entrepreneurship development (the interplay between individual characteristics and contexts for students' potential development as entrepreneurs)
2. Diversity of potential entrepreneurs and their trajectories

# Research Thread #1: What are the characteristics of advanced entrepreneurial students?

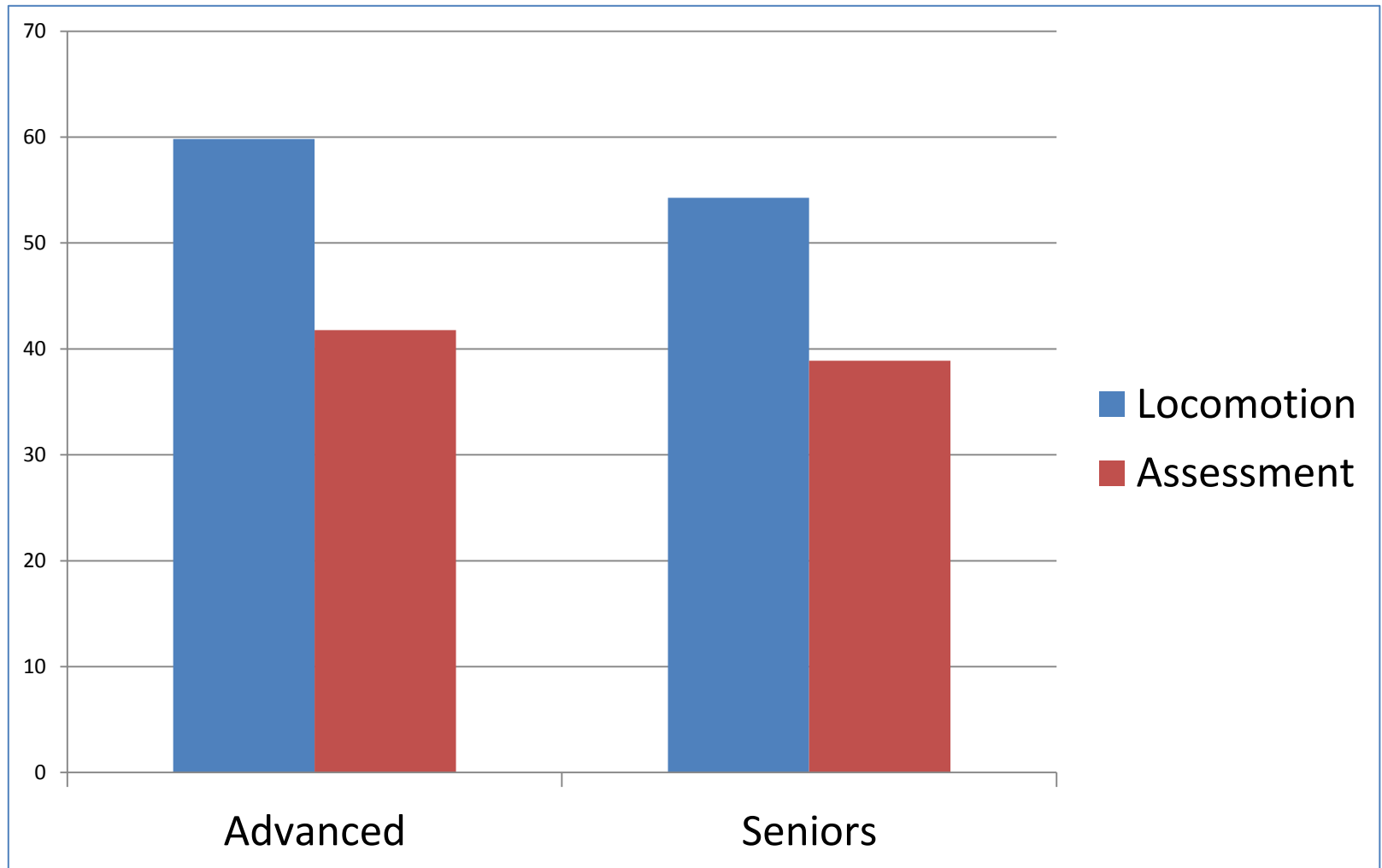
**Advanced students did not have higher entrepreneurial self-efficacy as compared to ENTI students ( $p=0.875$ ).**



**For creative self-efficacy scores, advanced students were not different than ENTI students but were higher than senior engineering students ( $p < 0.000$ )**



**Advanced students were found to have higher locomotion and assessment scores as compared to senior engineering students ( $p=0.003$ )**



# The interview data shows that advanced students feel that they are different from peers in multiple ways.

## 1. Actually doing something

*“I’m one of the few who’s actually going out and starting a business.”)*

## 2. Self-confident

*“...you need to be self-confident almost to the point of delusion...”*

## 3. More driven

*“Your biggest competitor is yourself. You’re the only person who’s moving things forward, and you’re the only person who’s holding things back.”*

## 4. Better with opportunity recognition

*“I think of the craziest ideas...Anything you see walking around, you notice a problem, you’d like to find a solution.”*



# Research Thread #2: Beliefs and perceptions of instructors who teach entrepreneurship

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## How do faculty define an entrepreneur?

### Most aligned:

Acts on opportunities  
Belief in future success  
Drive  
Passionate  
Resourceful

### Least aligned:

Marketing skills  
Learns from practice  
Learns from interactions  
Outgoing

# Research Thread #2: Beliefs and perceptions of instructors who teach entrepreneurship

**Do faculty believe the entrepreneurial mindset is developed or innate?**

Mean = 64.35

**Innate**

**Learned**

Drive  
Outgoing  
Passion  
Curious  
Comfort with ambiguity  
Comfort with risk

Business skills  
Technical skills  
Problem solving ability  
Communication skills  
Learn from failure  
Interpersonal skills  
Act on opportunities

# Research Thread #2: Beliefs and perceptions of instructors who teach entrepreneurship

## How do faculty members teach entrepreneurship?

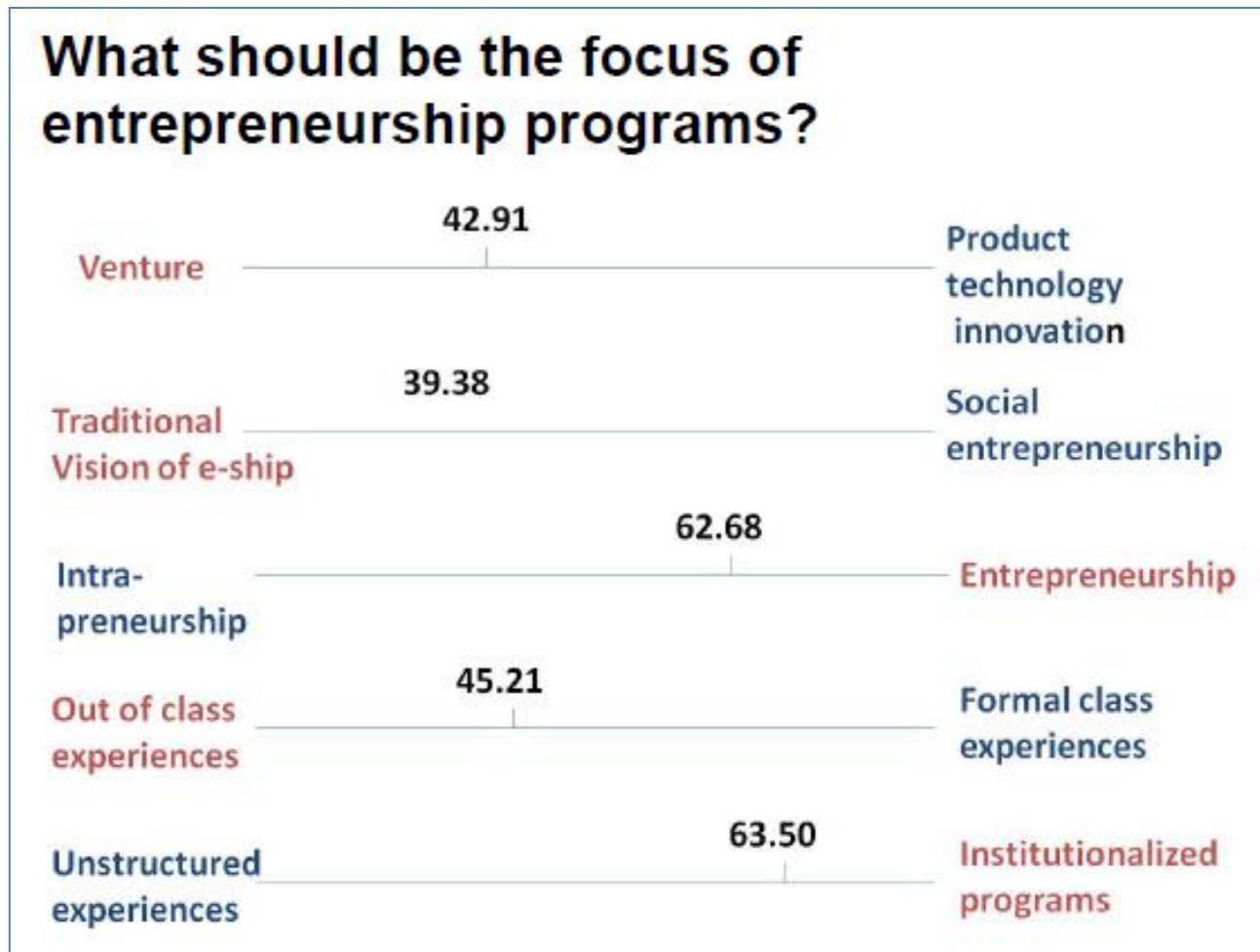
### Most often:

Student presentations  
Mentoring students  
Personal experiences  
Guest speakers  
Student elevator pitches  
Active learning

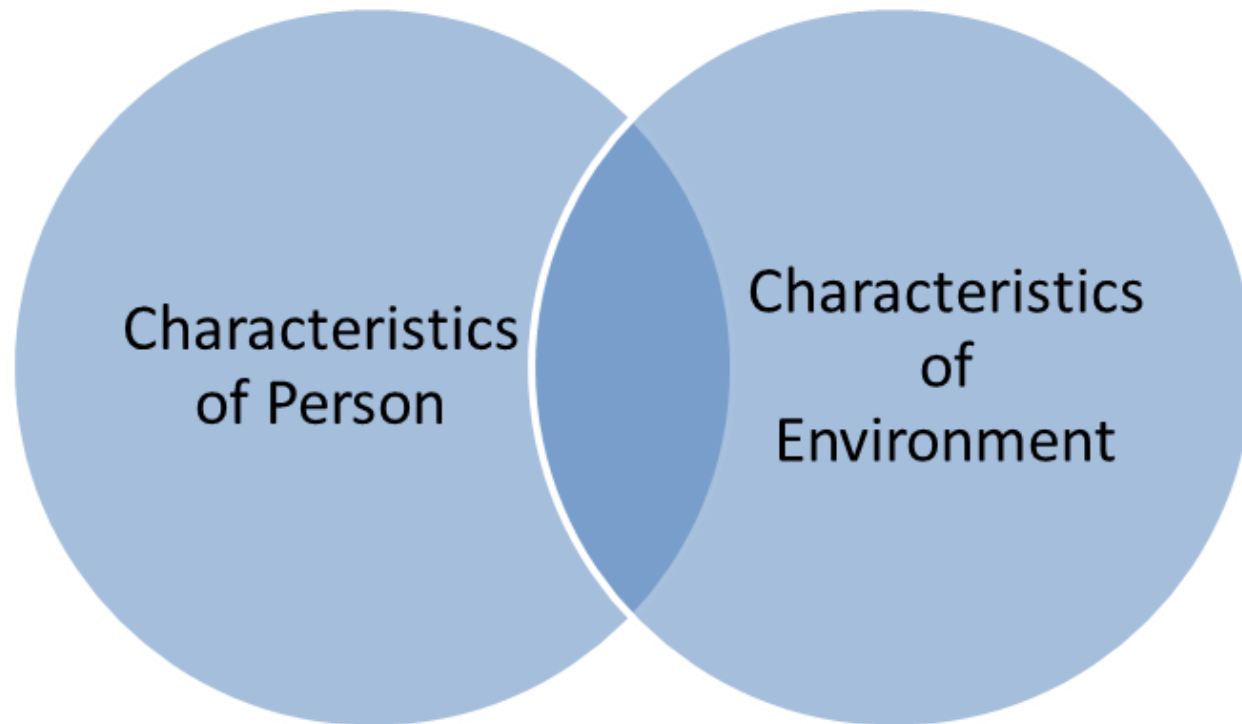
### Least often:

Textbooks  
Technology tools  
Long-term projects  
Have students practice  
Student-conducted interviews

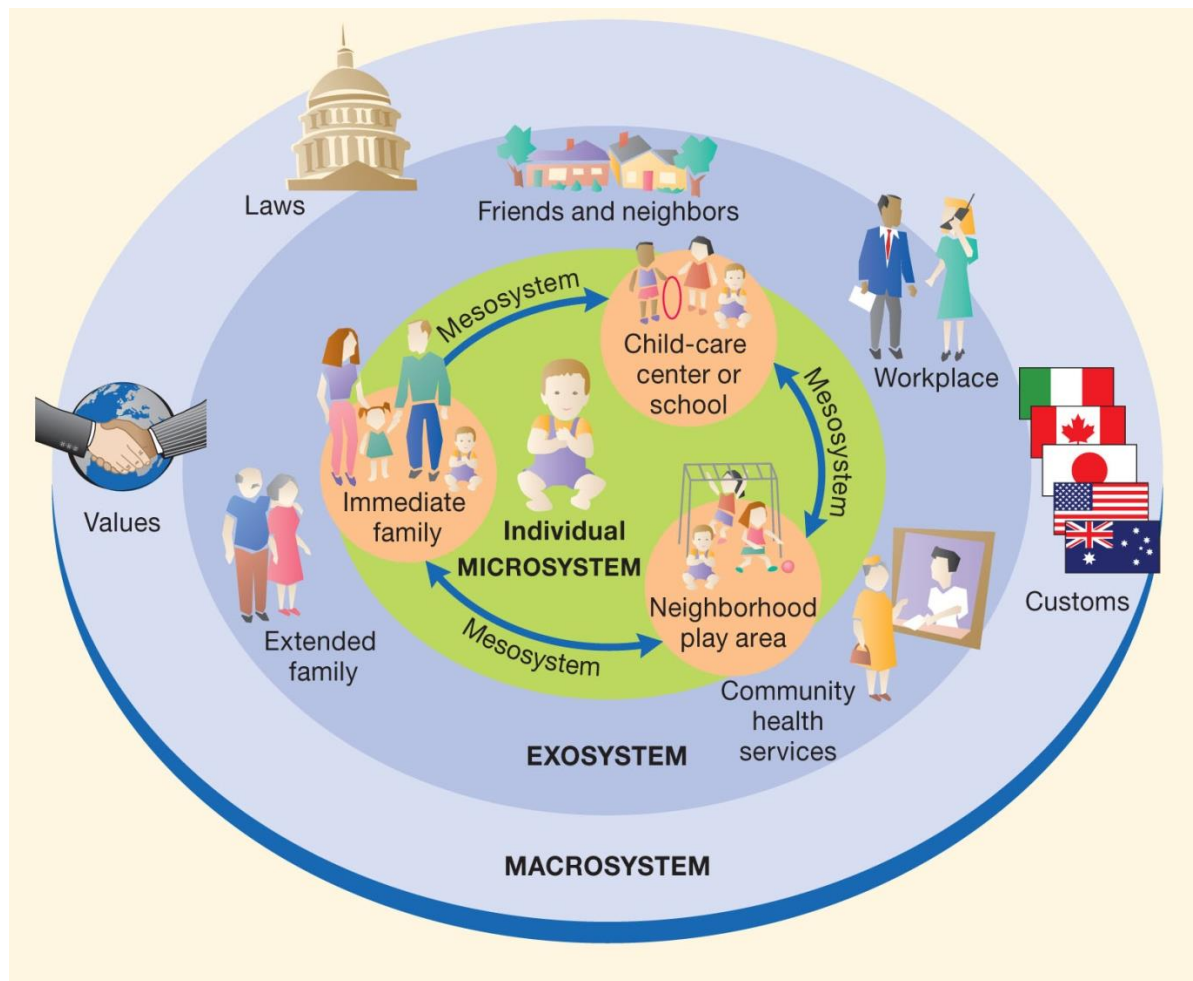
# Research Thread #2: Beliefs and perceptions of instructors who teach entrepreneurship



**A more integrative and interactive model of entrepreneurship education and development should be pursued in future research.**

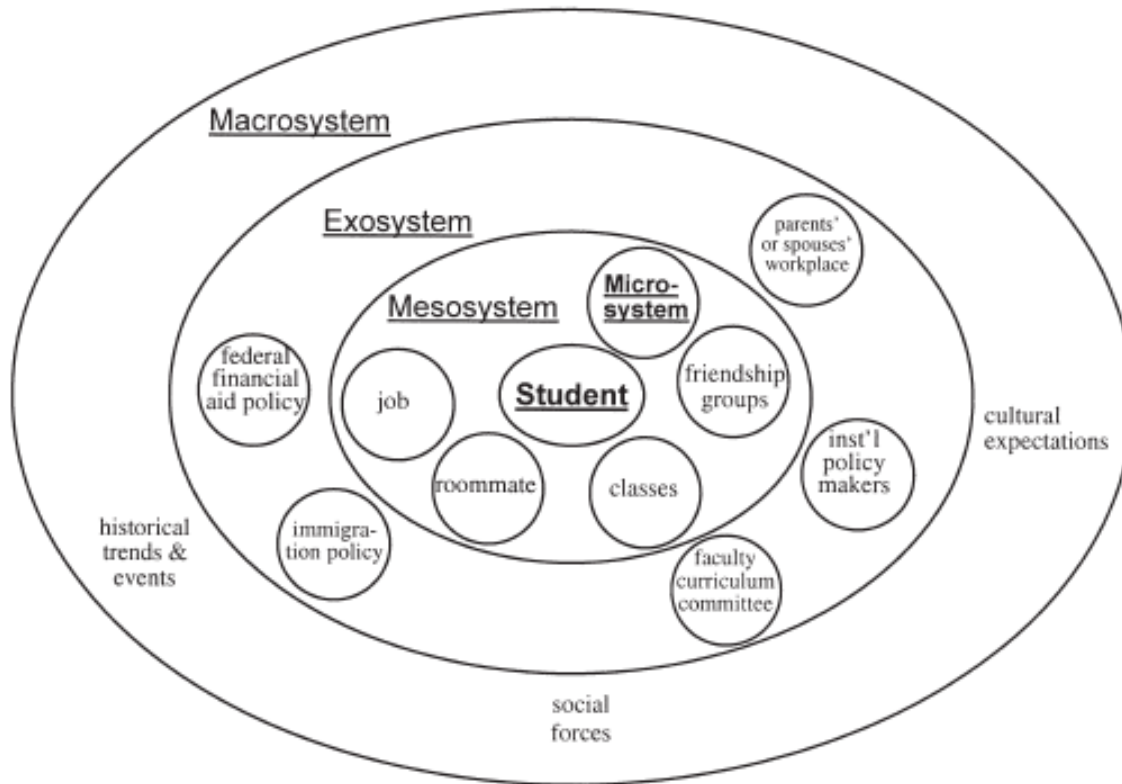


# Bronfenbrenner 's (1983) ecological systems model examines child development in terms of reciprocal relationships among elements of multiple environments.



Berk, L. E. (2012). *Infants, Children and Adolescents*. Allyn & Bacon: Boston, MA.

# Renn and Arnold (2003) applied this model in higher education in the context of studying the impact of peers on student development.



“...there is always an interplay between the psychological characteristics of the person and of a specific environment; the one cannot be defined without reference to the other” (Bronfenbrenner, 1989, p. 25).

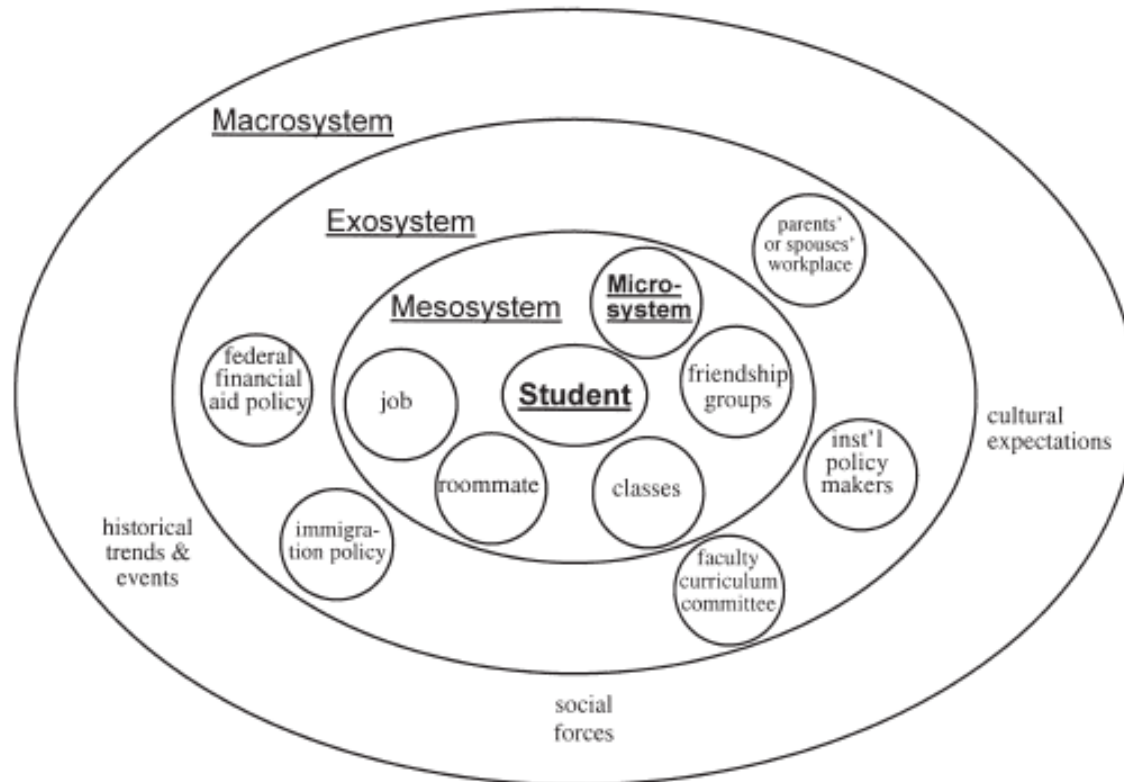
Renn & Arnold (2003). Reconceptualizing research on college student peer culture. *The Journal of Higher Education*. 74(3), 261-291.



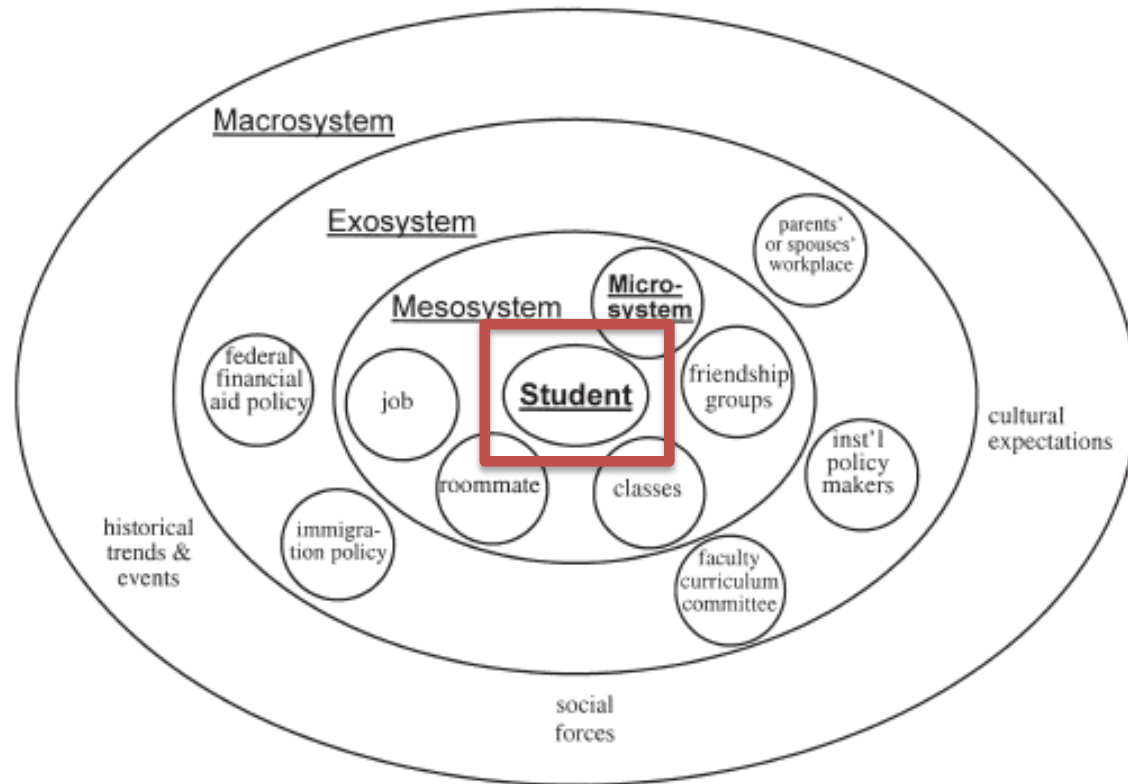
# Elements of ecological systems theory

1. Students react to and explore their surroundings differently.
2. Different students elicit different responses from others in environment (peers, faculty, etc).
3. Students differ in terms of how much they reconceptualize and create new features in the environment.
4. Students differ in terms of their agency in relation to their environments.

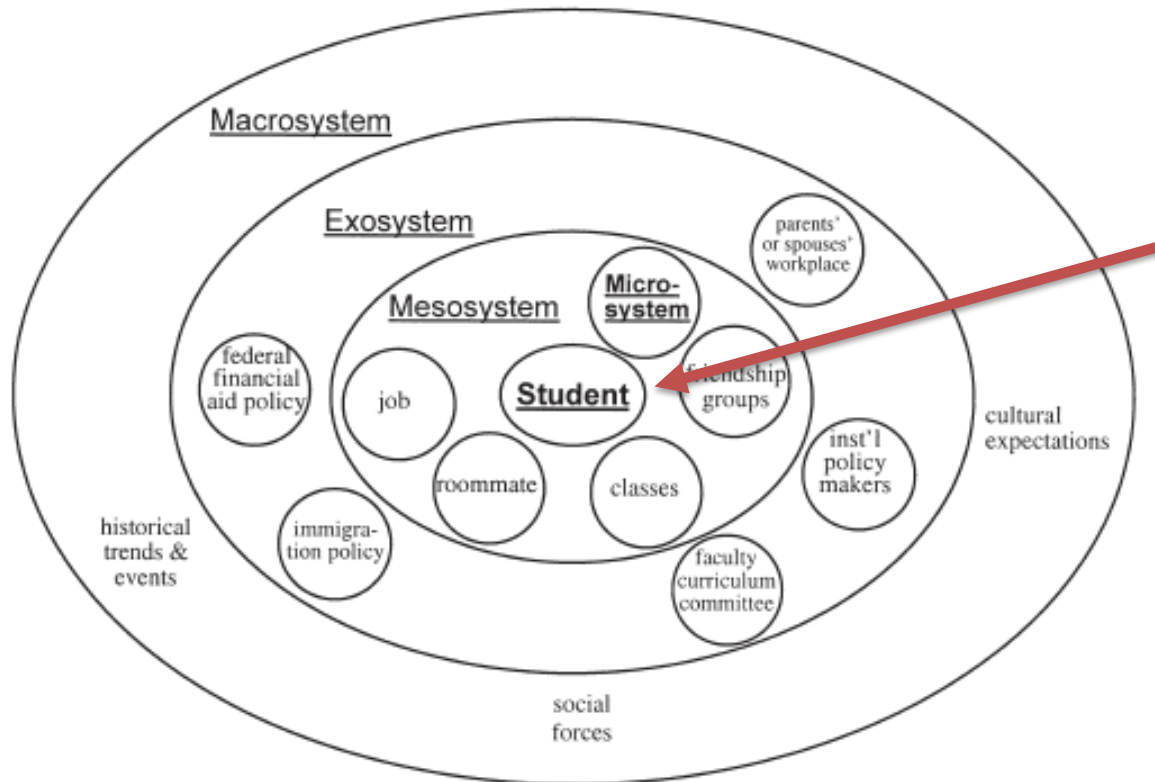
# How might we apply this model to student entrepreneurial development?



# Much research in entrepreneurship education has focused on student characteristics.



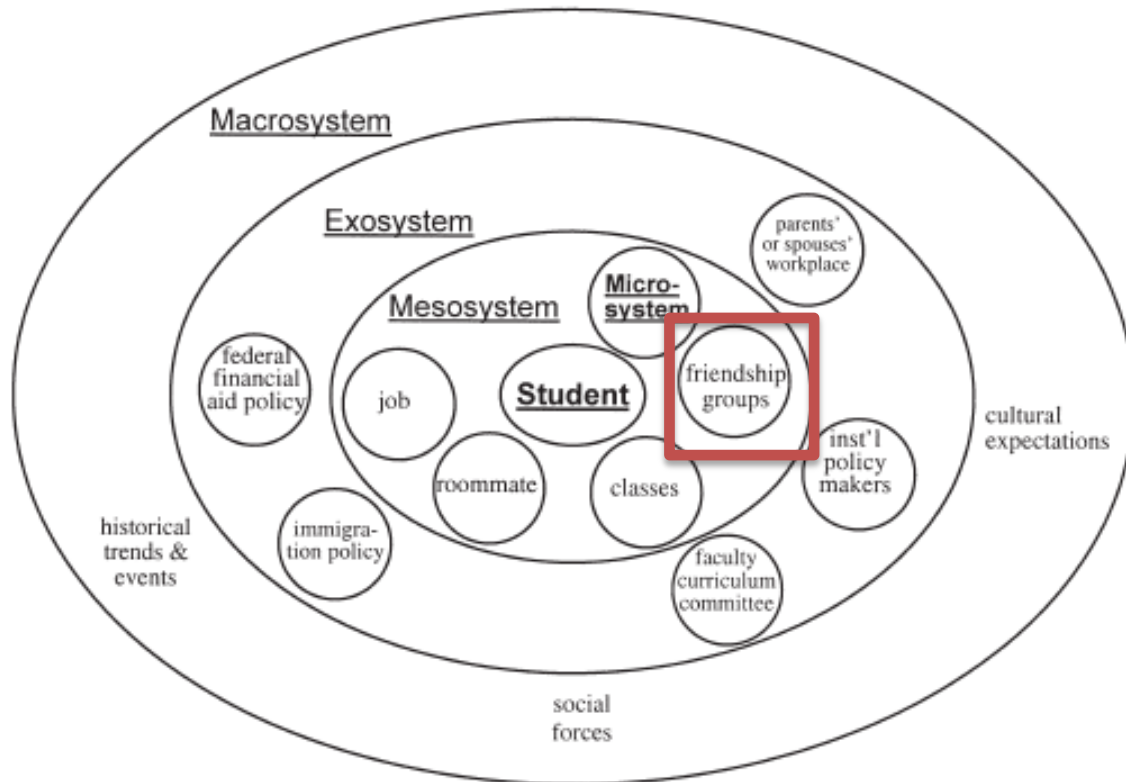
# How might we apply this model to student entrepreneurial development?



Having a parent or family member who is an entrepreneur is highly influential.

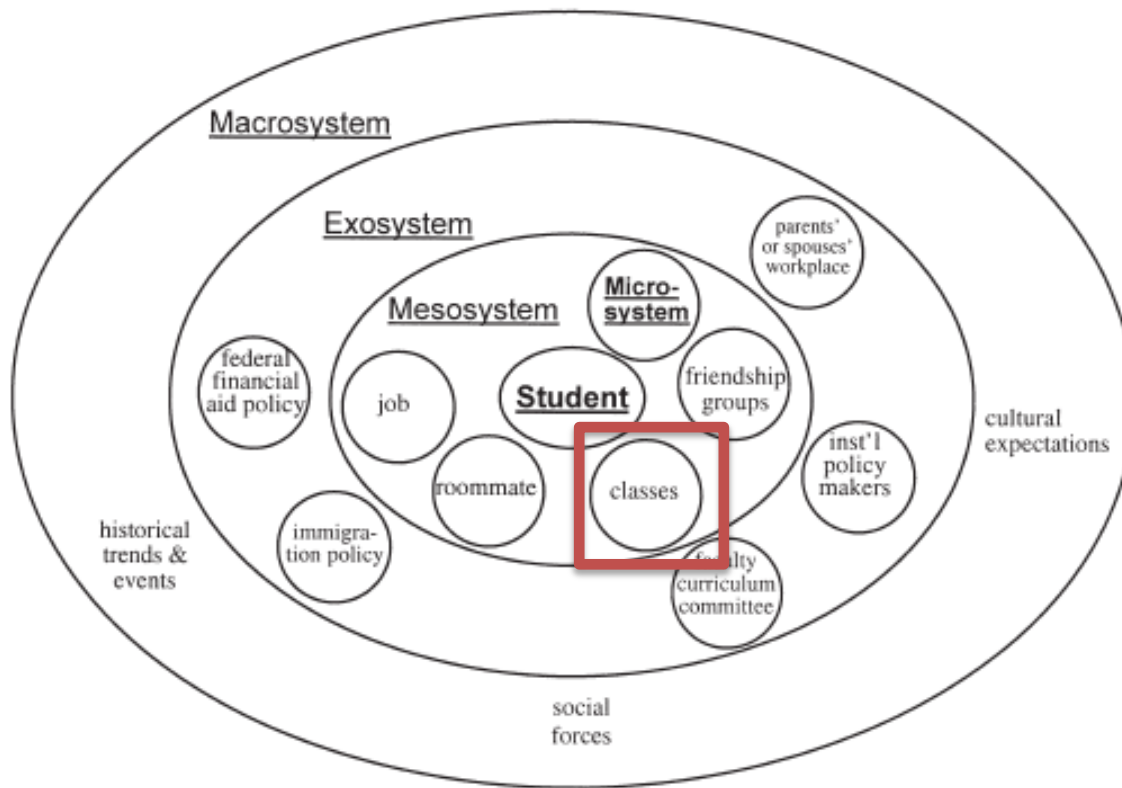
FIG. 1. Bronfenbrenner's Model as Applied to a Postsecondary Environment

# How might we apply this model to student entrepreneurial development?



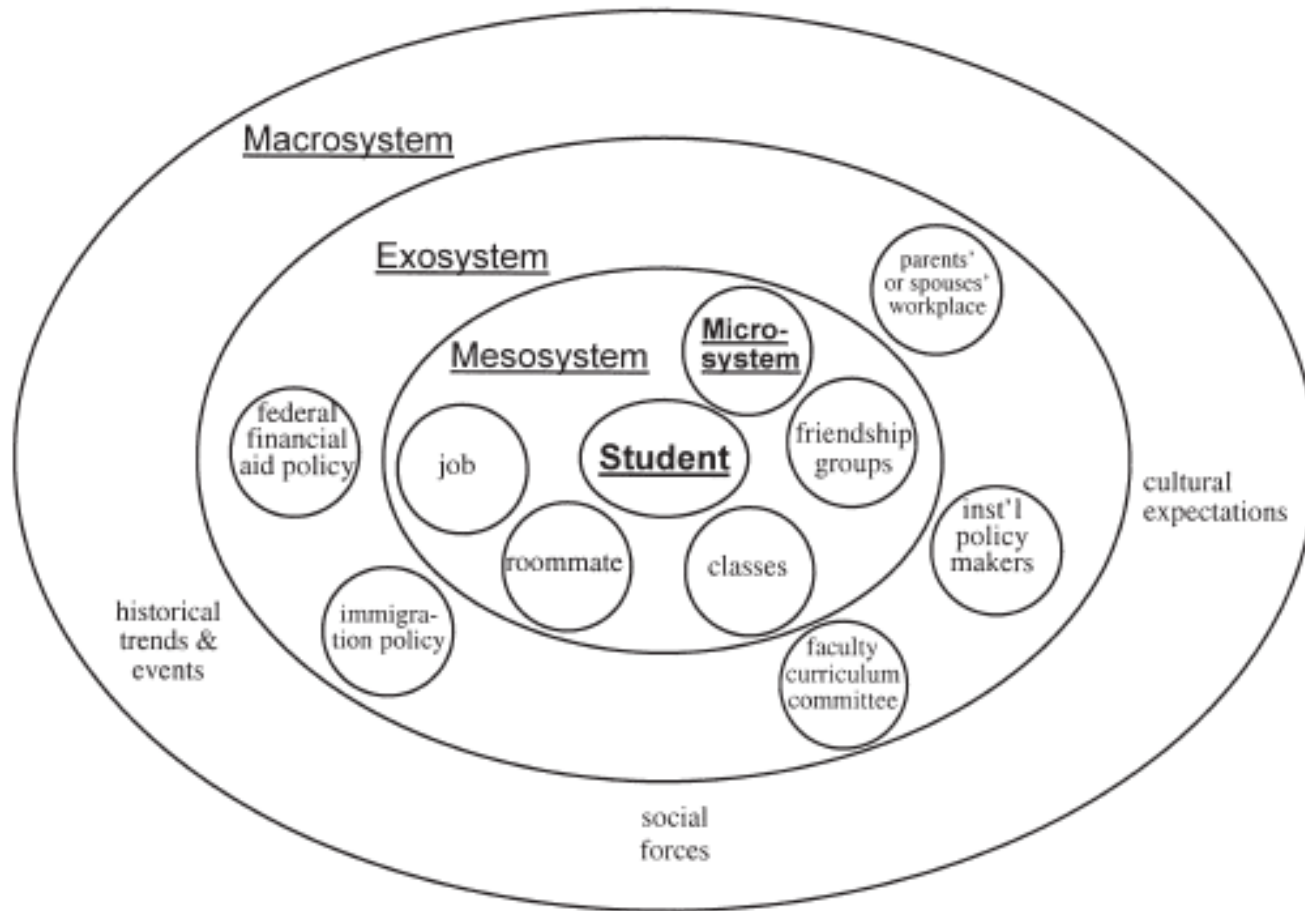
Peers may influence course and minor selection as well as open opportunities for entrepreneurial activities.

# The effect of university programs and courses provides just one force in student development.



“Even within the same setting, such as a seminar classroom, individuals will interact differently with that microsystem depending upon their backgrounds and developmental trajectories” (Renn & Arnold, p. 270).

# Other possible influences on student entrepreneurial development may fall into the various levels of the system.



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