Preparing Millennials for Technology, Team, and Data Complexity
How to teach SE to non-SE majors

PRESENTATION FOR INCOSE MIDWEST GATEWAY CHAPTER

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INTRODUCTION

• Background
  ➢ Higher Ed challenge
  ➢ Millennials characteristics

• What’s at stake for stakeholders?
  ➢ College grads get nearly all jobs
  ➢ Higher Ed evolving due to technology, globalization

• Teaching Systems Engineering (SE) to Non-SE majors

• Conclusion
BACKGROUND

HIGHER EDUCATION CHALLENGE

MILLENNIALS CHARACTERISTICS
Outgunned? U.S. needs a smarter, more creative workforce to retain competitive advantage

Competition – commerce of digital world

- 1.40 billion people in China
- 1.30 billion people in India
- 0.34 billion people in U.S.

Education Level of Individuals by Age Group, 2015

SOURCE: The College Board, Education Pays 2016, Figure 1.5B

For detailed data, visit: trends.collegeboard.org.
Postsecondary Enrollment Rates of the High School Class of 2011-12 and Percentage of All Adults with at Least a Bachelor’s Degree in 2014

% of All Youths Enrolling in Postsecondary Education

% of Adults 25 and Older with at Least a Bachelor’s Degree

SOURCE: The College Board, Education Pays 2016, Figure 1.7
HIGHER EDUCATION CHALLENGE

Provide employers with job candidates who

• Possess tech and soft skills, strong work ethic
• Life-long learners with strong team skills

Employers need qualified job candidates

• Science, Technology, Engineering, and Mathematics (STEM) positions hardest to fill with qualified candidates
HIGHER EDUCATION CHALLENGE

Provide Millennial students with

- Affordable education
- Teaching excellence
- Marketable degree options

Students want best shot at job market entry into global economy

- STEM majors are popular
HIGHER EDUCATION CHALLENGE
UNIVERSITY BUSINESS MODELS

• Are students the customer? Are parents? Employers?
• If students are customer,
  ➢ How do motivate your customer to work hard for you?
  ➢ Do you risk displeasing your customer – grades, etc.?
  ➢ Market focus – lazy rivers, i.e. LSU

Source: Photo tweeted by LSU

Like Congress, (some) universities hand future generations the bill for boondoggles.

People's self-theories about intelligence have a profound influence on their motivation to learn.

- **Fixed theory of intelligence** – Students concerned with being smart, doing well, avoiding mistakes, and not looking dumb.
- **Growth theory of intelligence** – students want challenge, increase abilities independently, take risks, not afraid to fail.

BACKGROUND

HIGHER EDUCATION CHALLENGE

MILLENNIALS CHARACTERISTICS
MILLENNIALS CHARACTERISTICS

• Student loan debt
• Time constrained
  ➢ 1st digital generation
• Anxiety
  ➢ Job market concerns
  ➢ Global concerns
  ➢ climate, war, globalization
• College preparedness

"Give Me A Break" - Joe Biden

Source: Joe Biden doesn't want to hear millennials complain, saying "give me a break"
Summer Meza - http://www.newsweek.com/joe-biden-says-millennials-dont-have-it-tough-780348
MILLENNIALS CHARACTERISTICS – College Graduates

- High GPAs, work and volunteer experience, travel
  - Importance of college education increases willingness to pay for it
  - Debt amplifies concern about getting and keeping a job
- Stiff entry-level job competition
- Aware college graduates had poor job prospects during and after Great Recession
MILLENNIALS CHARACTERISTICS –

How many students have one or more of the following characteristics?

1. Enter College unprepared for engineering courses
2. Lack college-level study skills
3. Underestimate degree of difficulty and fear failure
4. Need better problem-solving skills
5. Do not take enough ownership of learning process
6. Focus too much on grades
MILLENNIALS – CAMPUS EXPERIENCE

• 40% of freshmen need remedial Math, English\(^1\), both

• Have to learn more technology - software programs (Solidworks) and apps (Blackboard, Canvas, Moodle)

• More opportunities

  ➢ Dual degree programs, Internet/social media, study abroad, extra-curricular, internships, entrepreneurships, volunteerism, business opportunities, start-ups

MILLENNIALS – CAMPUS EXPERIENCE

• Some underestimate level-of-effort required for academic success (study hours). Possible reasons -
  ➢ K12 grade inflation, insufficient problem-solving (PS) and critical thinking (CT)
  ➢ Student rewards for participation instead of highest achievement

• Some students overestimate value of a degree vs. value of what they learn, hard time searching jobs
  ➢ More emphasis needed on life-long learning
MILLENNIALS – DEGREE USEFULNESS

• Engineering majors most likely to say current job “very closely” related to field of study

• Engineering majors are less likely to say they should have chosen different major to better prepare for job they wanted

Usefulness of Major, by Field of Study

<table>
<thead>
<tr>
<th>Field of Study</th>
<th>Very closely</th>
<th>Somewhat closely</th>
<th>Not very closely</th>
<th>Not at all</th>
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<tbody>
<tr>
<td>Science/Engineering</td>
<td>60</td>
<td>18</td>
<td>6</td>
<td>15</td>
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<tr>
<td>Social Science/Liberal Arts/Education</td>
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<td>17</td>
<td>12</td>
<td>28</td>
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<tr>
<td>Business</td>
<td>43</td>
<td>29</td>
<td>15</td>
<td>12</td>
</tr>
</tbody>
</table>

Note: Based on those with at least a bachelor’s degree who are employed full time or part time (n=605). “Don’t know/Refused” responses not shown.

MILLENNIALS – MISSED OPPORTUNITIES

Students felt they could have been better prepared

- Gained more work experience to position them better for job they want (50%)
- Regretted not studying harder (38%)
- Should begin their job search earlier (30%)
- Should pick a different major (29%)

College Days, Reconsidered

% who say doing each of the following while they were undergraduates would have better prepared them to get the job they wanted

- Gaining more work experience: 50%
- Studying harder: 38%
- Looking for work sooner: 30%
- Choosing a different major: 29%

Note: Based on those with at least a bachelor’s degree (n=790). Voluntary responses of “Maybe” not included.

MILLENNIALS WORKFORCE – LITERACY GLOBAL COMPETITION

By 2030 Millennials make up 75% of U.S. workforce¹

• U.S. millennials lag behind most foreign peers in technical skills²

• U.S. Millennials score below OECD’s³ average for literacy, numeracy, and problem-solving in technology-rich environments

¹ The U.S. Bureau of Labor Statistics
² ETS study of the OECD’s PIAAA test results
³ OECD - Organization for Economic Co-Operation and Development
MILLENNIALS WORKFORCE – LITERACY GLOBAL COMPETITION

Figure 1. Average scores on PIAAC literacy scales for adults age 16–34 (Millennials) and adults age 16–24, by participating country/region: 2012.

Figure 2. Average scores on PIAAC numeracy scales for adults age 16–34 (Millennials) and adults age 16–24, by participating country/region: 2012.

Figure 3. Average scores on PIAAC problem-solving in technology rich environments (PS TRE) scales for adults age 16–34 (Millennials) and adults age 16–24, by participating country/region: 2012.

PAYSCALE, surveyed 63,924 managers and 14,167 recent graduates in 2016

1. Graduates do not pay attention to detail (56% of managers)
2. Young workers would do well to hone their communication skills (46% of managers)
3. Lack of leadership qualities (44% of managers)

MILLENNIALS WORKFORCE – SOFT SKILLS

PayScale, surveyed 63,924 managers and 14,167 recent graduates in 2016

4. Insufficient interpersonal/teamwork skills (36% of managers)
5. Lacking in public speaking skills (39% of managers)
6. Graduates need to bone up on data analysis — Excel, Tableau, Python, R (36% of managers)

COLLEGE GRADS GET NEARLY ALL JOBS

Of 11.6 million jobs created after Great Recession, 8.4 million went to bachelor's degree recipients

Another 3 million went to associate's degree recipients and students with some college

"Employers want workers with at least some college education"

Rising Cost of Not Going to College

On virtually every measure of economic well-being and career attainment

- personal earnings
- job satisfaction
- Full- vs part-time employment

young college graduates outperforming peers with less education

Median Earnings and Tax Payments of Full-Time Year-Round Workers Age 25 and Older, by Education Level, 2015

SOURCE: The College Board, Education Pays 2016, Figure 2.1

For detailed data, visit: trends.collegeboard.org.
COLLEGE GRADS GET NEARLY ALL JOBS

Over 99% of job growth in the recovery went to workers with more than a high school education

Workers with a high school diploma or less saw virtually no job market recovery after 2008 Great Recession

Employers made STEM graduates top-paid class of 2017 members. Engineering led the way with an average salary of $66,097.

HIGHEST SALARY PROFESSIONS
SOURCE: GLASS DOOR

1. Anesthesiologist: $208,000 Median Salary
2. Surgeon: $208,000
3. Obstetrician and Gynecologist: $208,000
4. Oral and Maxillofacial Surgeon: $208,000
5. Orthodontist: $208,000
6. Physician: $196,380
7. Psychiatrist: $194,740
8. Pediatrician: $168,990
9. Dentist: $153,900
10. Prosthodontist: $126,050
13. IT Manager: $135,800
14. Marketing Manager: $131,180
15. Podiatrist: $124,830
16. Lawyer: $118,160
17. Financial Manager: $121,750
18. Sales Manager: $117,960
19. Financial Advisor: $90,530
21. Pharmacist: $122,230
22. Optometrist: $106,140
23. Actuary: $100,610
24. Political Scientist: $114,290
25. Medical and Health Services Manager: $96,540


SOURCE: The College Board, Education Pays 2016, Figure 2.9

For detailed data, visit: trends.collegeboard.org.
Estimated Cumulative Full-Time Earnings (in 2014 Dollars) Net of Forgone Earnings and Payment for Tuition and Fees and Books and Supplies, by Education Level

SOURCE: The College Board, Education Pays 2016, Figure 2.2A
TEACHING SE TO NON-SE STUDENTS

What Golf .... and the New INCOSE v4 Handbook .... Can Teach Us About Systems Engineering

IMAGE: INCOSE
TEACHING SE TO NON-SE MAJORS –

• ME, EE, AE, CE, BME
  ➢ SE electives only
  ➢ Curricula full, courses challenging
  ➢ ESL and SE terminology - barriers

• SE at work – difficult to teach on campus
  ➢ IPTs, Agile, flat vs. hierarchical organizations
  ➢ Large-scale projects require SE
  ➢ Complexity – tech, cost, schedule, logistical, etc.
TEACHING SE TO NON-SE MAJORS –

• Methods, processes, codes, standards, theory (software), technology – SE can be learning roadmap
  ➢ SE is how to design, manage complex systems over life cycles
  ➢ Examples - requirements, determining design drivers
  ➢ Steep learning curves, learn faster than older workers
  ➢ Inexperienced, older workers leverage prior knowledge better

• Interdisciplinary course development needed

• More experiential learning - facilitated, active learning
  ➢ Foundation for understand/apply what is learned
  ➢ Sever/Industry student learning partnerships

• SE span curriculum, integral to teaching IL/PS/CT
TEACHING SE TO NON-SE MAJORS - OBSTACLES

• Faculty for course integration, modification
• More collaboration between academic depts.
• Articulate SE value proposition
  ➢ students, parents, faculty, administrators
• Integrated software tools needed for LMS
  ➢ Blackboard, Canvas, Moodle, etc.
  ➢ LMS can hinder sharing information, changes
TEACHING SE TO NON-SE MAJORS – INTERDISCIPLINARY PROGRAMS (IP)

• Requires more IP, project-based courses
• Faculty support for IP from administrators
  ➢ Logistics, workload, coordination
• IP need full integration into curriculum
  ➢ past courses largely stood alone
  ➢ Individual faculty cannot be required to sustain IP
• IL/PS/CT - projects with SE content
  ➢ Engineering roles, cost accounting, scheduling, etc.
Therefore, education needs to shift “from education as a content transfer to learning as a continuous process where the focused outcome is the ability to learn and adapt with agency as opposed to the transactional action of acquiring a set skill,” said McGowan.

“Instructors/teachers move from guiding and accessing that transfer process to providing social and emotional support to the individual as they move into the role of driving their own continuous learning.”

CONCLUSION

1. Quality education requires *teaching excellence*
   Innovation requires life-long *learning excellence*
   ➢ Curiosity, ideation, creativity, risk-taking, setting ambitious goals, ingenuity
   ➢ *Difficult to teach, can be encouraged, acquired*

2. SE is an excellent growth mindset framework, IL/PS/CT

*At stake - new intellectual wealth Millennials will build on their foundation of inherited intellectual wealth*
For more information, visit:

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