Computer Games as a Future of Manufacturing Education

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namrc47
North American Manufacturing Research Conference

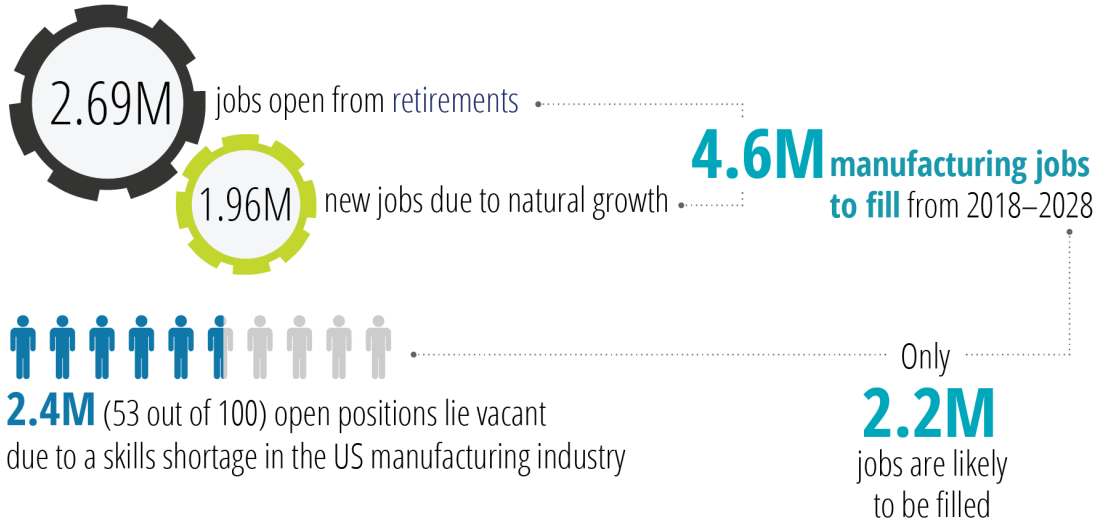
PennState Behrend
International Advanced Manufacturing Conferences

MSEC
Manufacturing Science and Engineering Conference

2.4 million unfilled positions puts US$2.5 trillion at risk over next 10 years

FIGURE 1

The skills gap may leave an estimated 2.4 million positions unfilled between 2018 and 2028



*Calculated on the basis of 52.7% of the skilled manufacturing positions that are unfilled (per the 2018 survey)
**Retirement age of 66

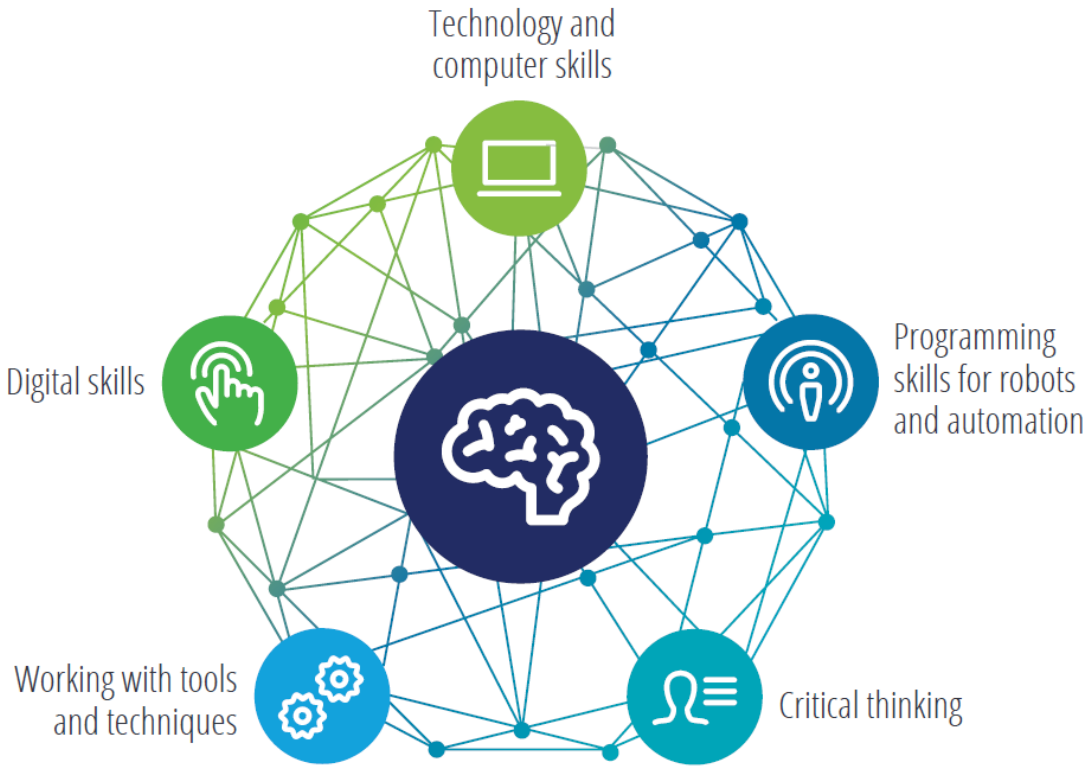
Source: BLS Data, OEM (Oxford Economics Model), Deloitte and Manufacturing Institute skills research initiative.

Deloitte Insights | deloitte.com/insights

Skills shortage could put US$454 billion of manufacturing GDP at risk in 2028 alone

Solution: Hire more people!

But we don't have enough skilled people in manufacturing, yet!



Five key skills expected to be needed in the fourth industrial revolution

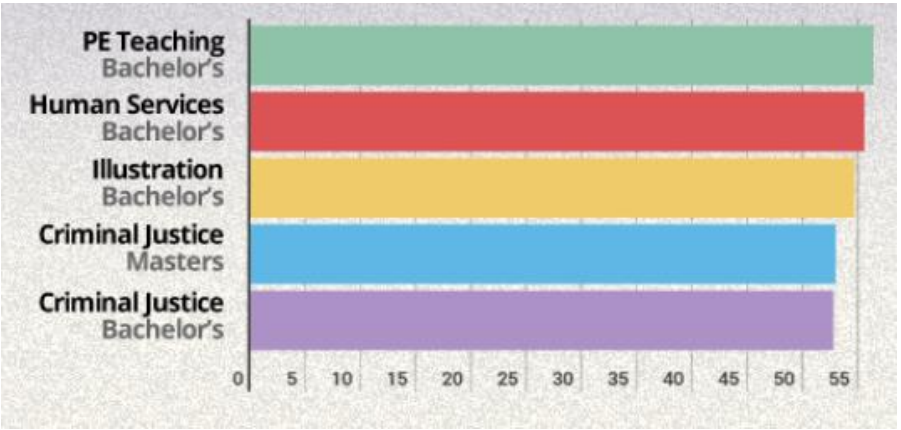
Where to find potential manufacturing workforce?

STEM students in universities and community colleges: ~6 million

- Train them well for a career in advanced manufacturing.
- Retention rate for community college = ~60%: one of the three reason is **hard coursework.**
- **Q: How do we improve student's understanding, learning and retention?**

Underemployed people: ~22 million

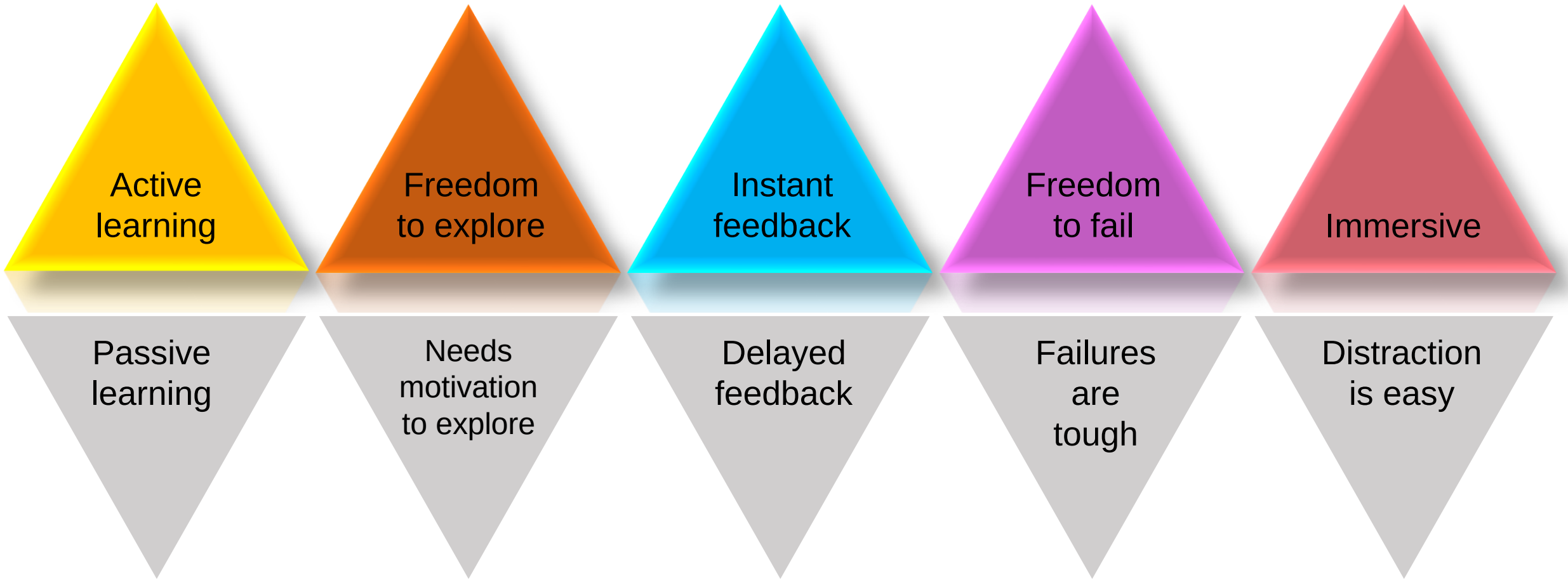
- Many are univ. graduates, in low paying jobs.
- Motivated for high-paying and in-demand jobs.
- **Q: How do we provide necessary education & training for non-majors?**



https://www.payscale.com/data-packages/underemployment/degree-and-major

https://nsf.gov/nsb/sei/edTool/data/college-02.html
https://www.americashealthrankings.org/explore/annual/measure/Underemployed/state/ALL

Can we use computer games to improve student's engagement and retention?



Computer games in this context means any kind of digital game, played on any platform (PC, mobile, tablet) etc.

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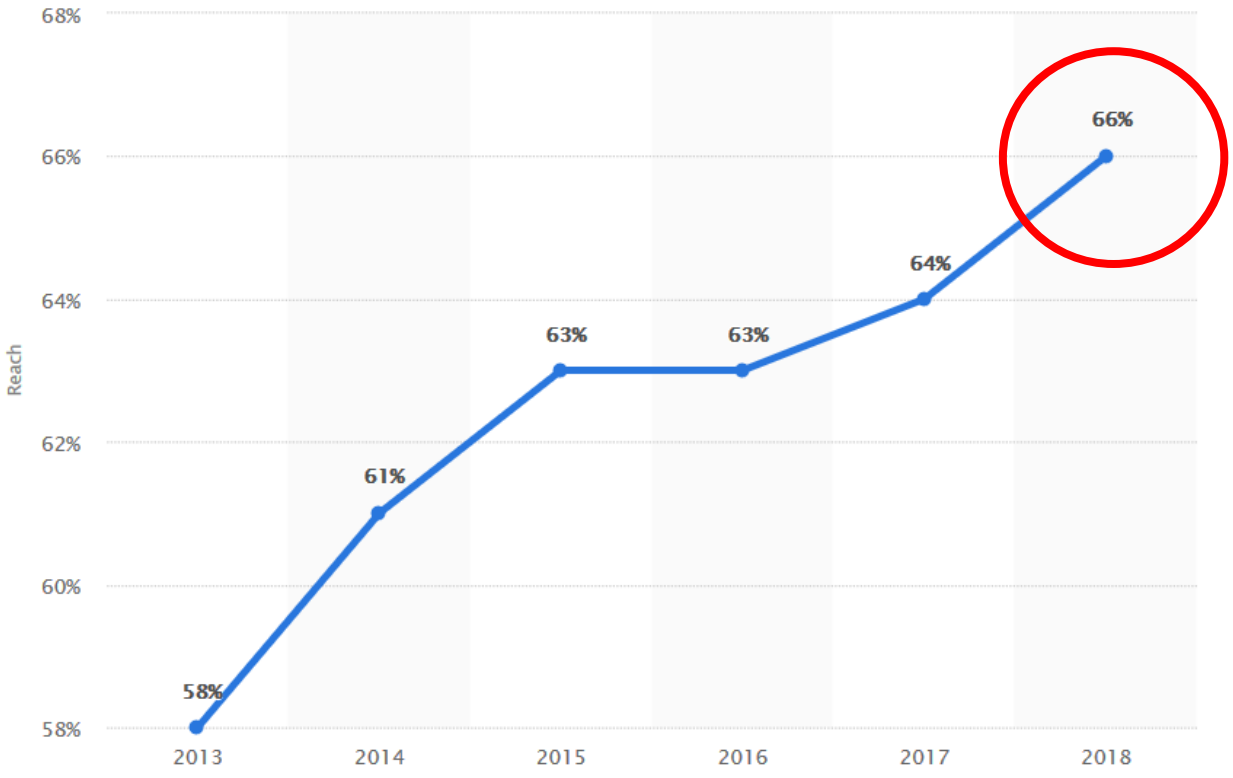
Why computer games?: they appeal to our target audience!!



Game penetration: general U.S. population^

Male/Female ratio*: 55/45

Play an average of **6 hours/week****!

If people are used to **playing games**, why not **make them learn** in the same framework?

"The role of a teacher and the role of game rules are roughly equivalent. A teacher wants to exert influence on students to encourage certain behaviours; to reward the positive and discourage the negative. In games, rules are designed to guide players through a level or stage in an intuitive manner."

– Steven Lumpkin, Senior Designer, RollerCoaster Tycoon World

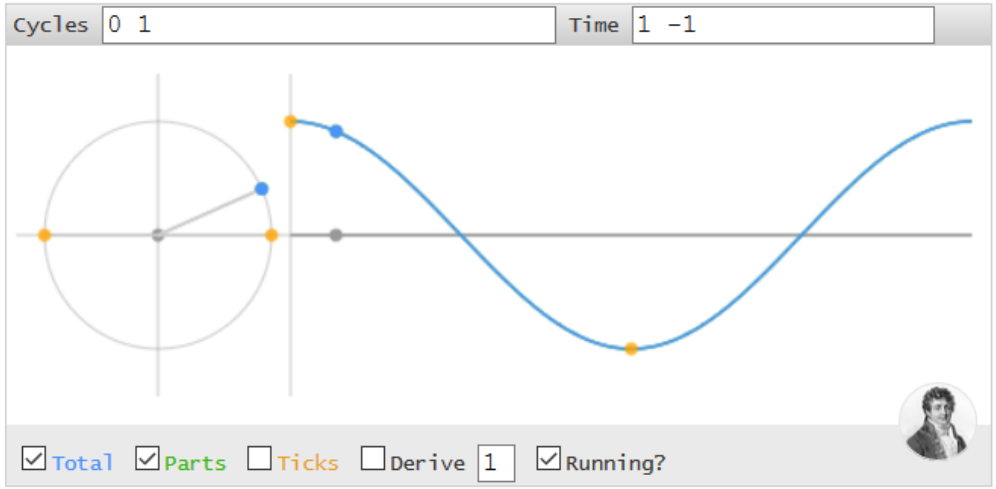
^https://www.statista.com/statistics/748835/us-gamers-penetration-rate/
*https://www.statista.com/statistics/232383/gender-split-of-us-computer-and-video-gamers/
**https://www.limelight.com/resources/white-paper/state-of-online-gaming-2018/

Some examples from my experience

Fourier Transforms

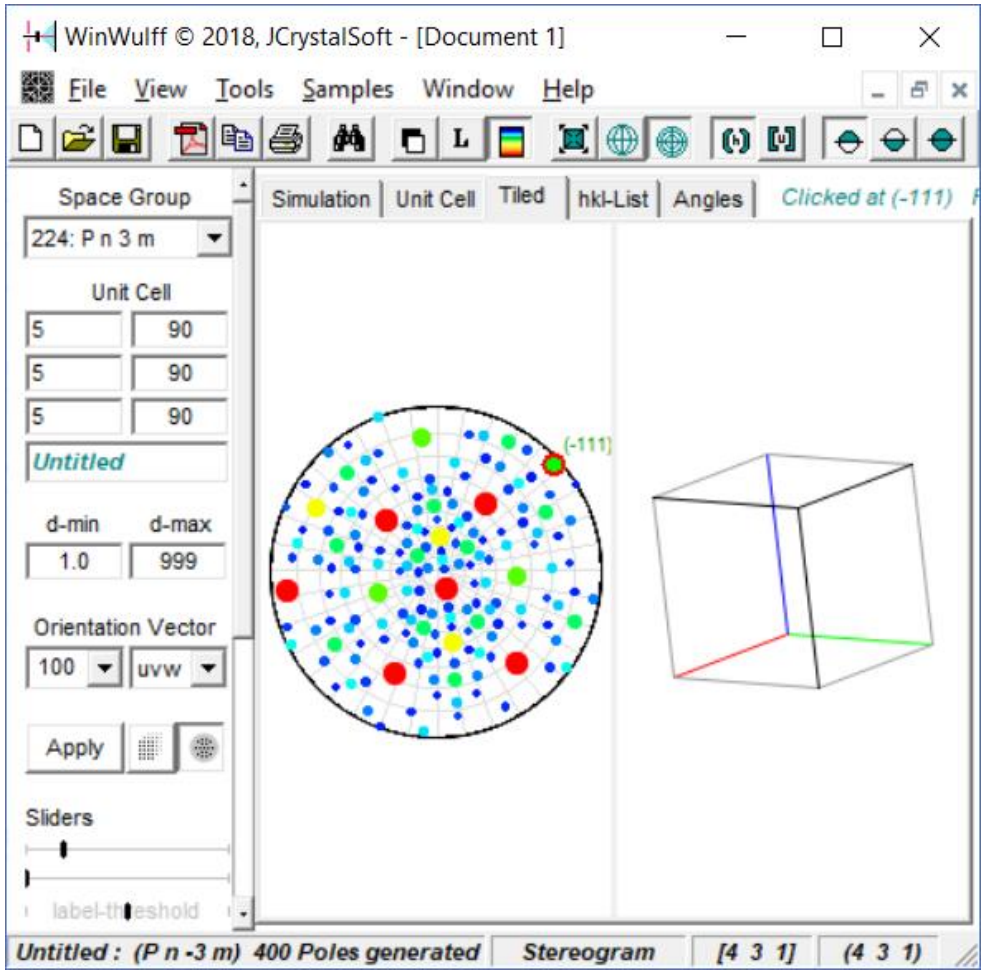
$$X_k = \sum_{n=0}^{N-1} x_n \cdot e^{-i 2\pi k n / N}$$

$$x_n = \frac{1}{N} \sum_{k=0}^{N-1} X_k \cdot e^{i 2\pi k n / N}$$



https://betterexplained.com/articles/an-interactive-guide-to-the-fourier-transform/

Stereographic Projection



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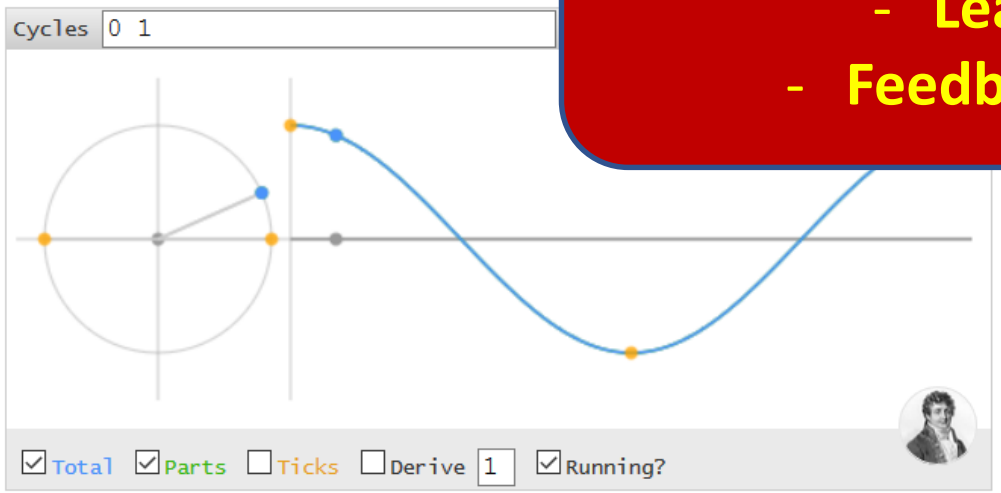

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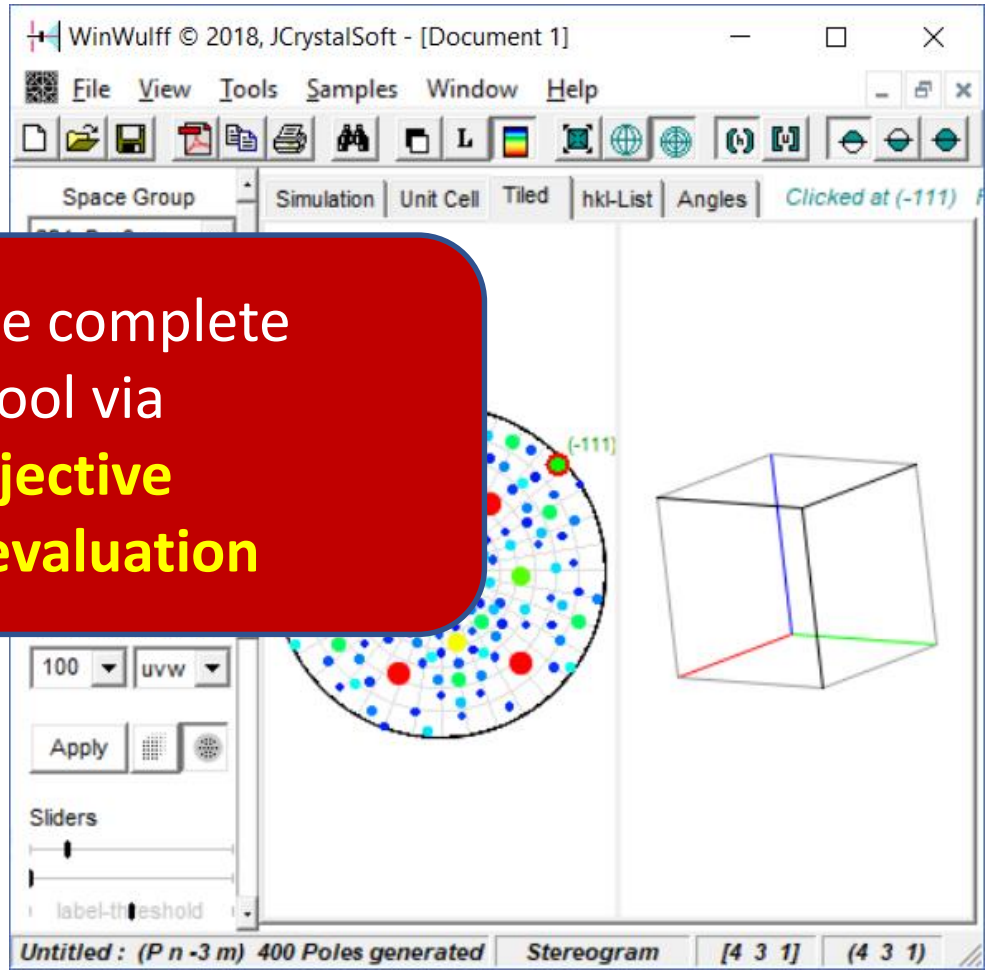

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Potential to become complete instructional tool via

- **Learning objective**
- **Feedback and evaluation**

Successful trials of gamification in manufacturing education

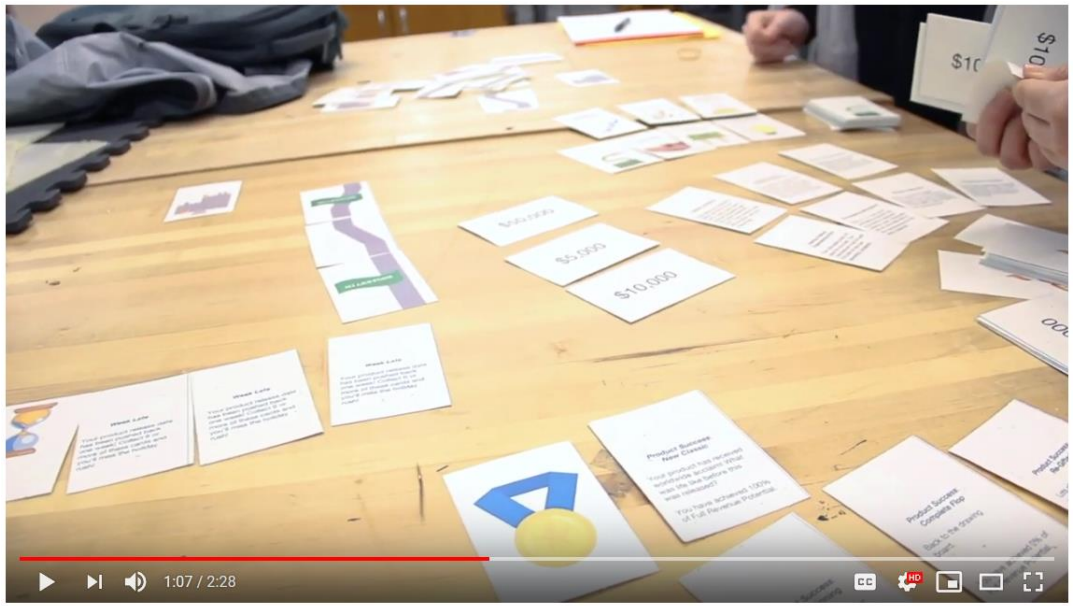
UT Dallas introduces Minecraft for Polymer Chemistry (2014)

- The "Polycraft World" modification allows "**Minecraft**" players to create flamethrowers. But to do so, players **learn about plastics processing** in order to refine and fabricate the necessary components to build them.
- **"Fun and learning do not have to be diametrically opposed"**

https://www.utdallas.edu/news/2014/10/24-31265_UT-Dallas-Team-Infuses-Materials-Science-into-Mine_story-wide.html

CMU's Professor Rebecca Taylor introduces card game (May 15th 2019)

- Students **learn contract manufacturing and negotiation** while navigating a **student-inspired card game** that reveals challenges and successes during the product development process.



Modern Manufacturing in Steeltown with Assistant Professor Rebecca Taylor

https://www.youtube.com/watch?v=KKyJ2rPXV9M

Many pilot studies elsewhere: strong belief in gamification techniques

NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

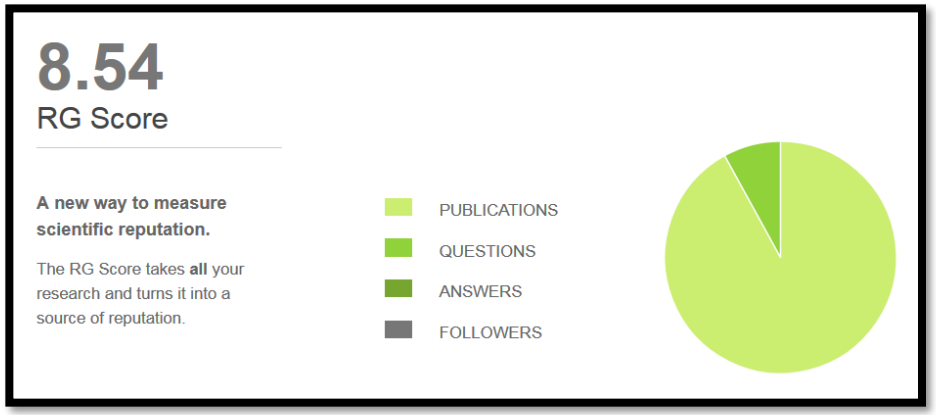
Thesis on – "LEVERAGING GAMIFICATION TECHNIQUES AND STRATEGIES AS A MEANS OF IMPROVING MARITIME BORDER SECURITY DATA COLLECTION" (2017)

Front Physiol. 2018; 9: 908.
PMCID: PMC6060613
Published online 2018 Jul 19. doi: 10.3389/fphys.2018.00908
PMID: 30072911

Can Gamification Contribute to Computer Modeling-Driven Biomedical Research?

'Gamification' Techniques Increase Your Employees' Ability To Learn By 40% - Business Insider

Many industries actively uses AR/VR techniques for training employees



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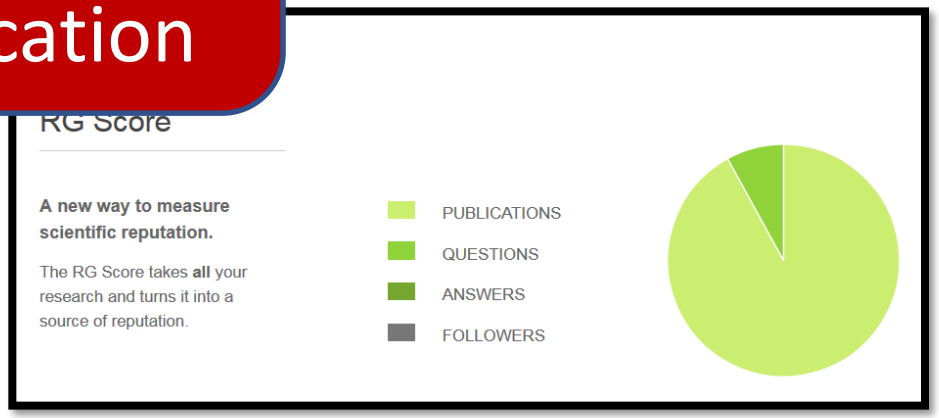
Can Gamification Contribute to Con
Research?

Lack of framework for gamification of manufacturing education

**'Gamification' Technique
Ability To Learn By 40% - Business Insider**



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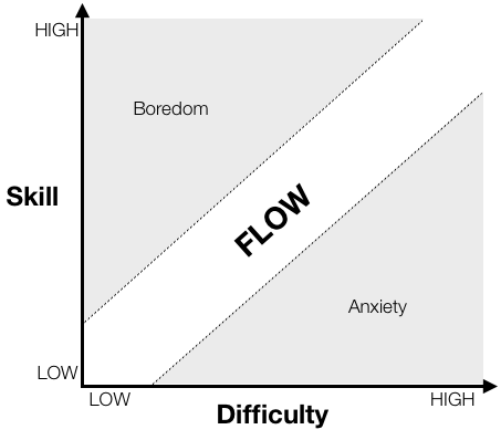
Research Needs to develop framework for in mfg. education

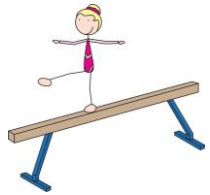
Explore game design concepts (and tools, platforms) for mfg. education



Develop feedback mechanism: how and when?

What can be gamified and how? Develop best practices

How to balance classroom v/s gaming content?



What data to collect and how to best use?

Instructors (many fields)	**Computer scientists**	**Gaming researchers**
Pedagogy researchers	**Psychologists**	**Statisticians**

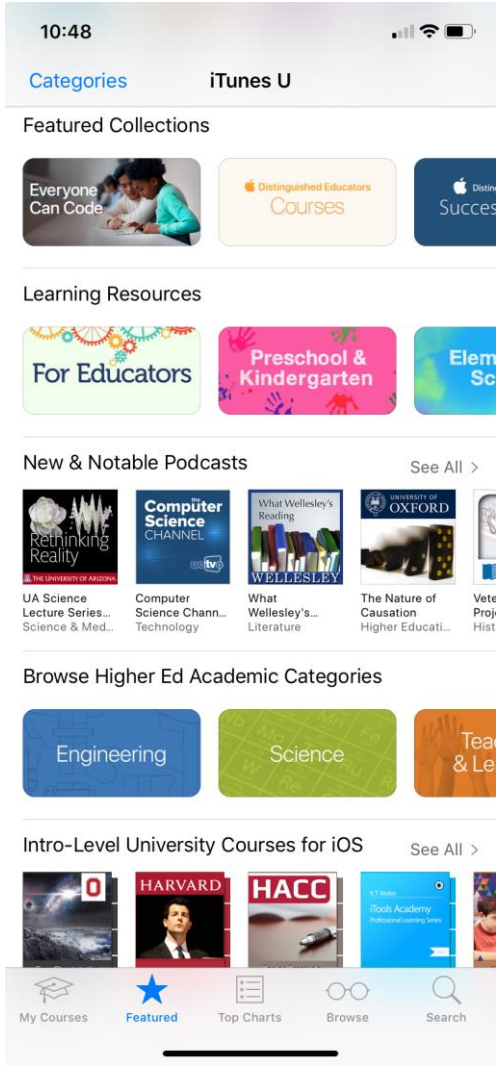
Vision: computer games as future of manufacturing education

- Improve student's engagement, learning and retention by introducing gaming elements in delivering manufacturing education.
- Universities and industry, together, create a rich gamified curriculum to impart manufacturing skills in-demand. Creation of curriculum such as "manufacturing for non-majors."
- Use of big data to (a) improve learning experience, (b) target untapped potential, and (c) connect workforce to opportunities.
- Develop the manufacturing workforce of the future by changing the ways of delivering education today.

Thank You!

2.4M (53 out of 100) open positions lie vacant due to a skills shortage in the US manufacturing industry

MANUFACTURING Institute



Manufacturing GDP