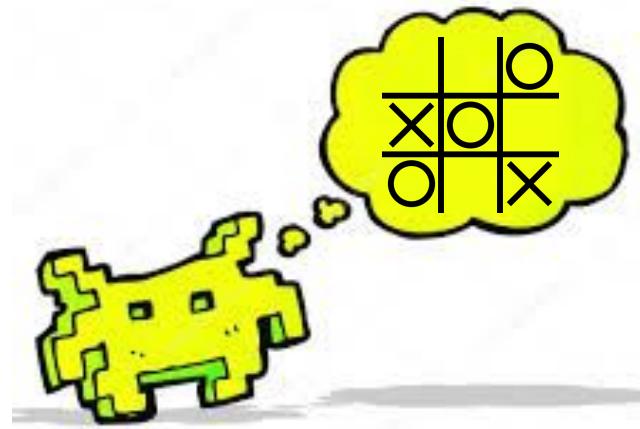


How to Design and Build an Interactive Game for Teaching and Learning



Laura Perissinotti, Wilian Gatti Junior
Isadora Mok-Kulakova and Kevin Saito

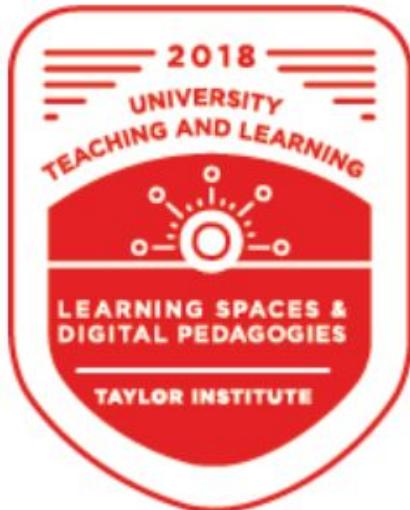


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An important reminder

Please sign in!

*If your name is not on the sign-in sheet, please add it together with your email address – you will be registered after the workshop. *Also, use the sign-in sheet to correct your name or email.*



This badge is part of the **Postdoctoral Scholar** and **Graduate Student** Certificates in University Teaching and Learning program.

<http://www.ucalgary.ca/taylorinstitute/certificates>

Play and Games

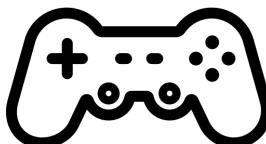
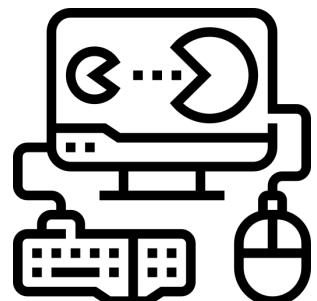
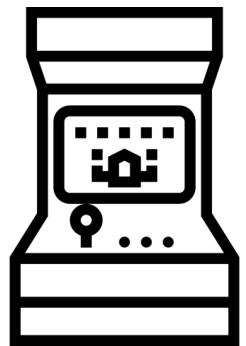
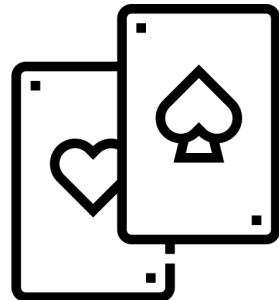
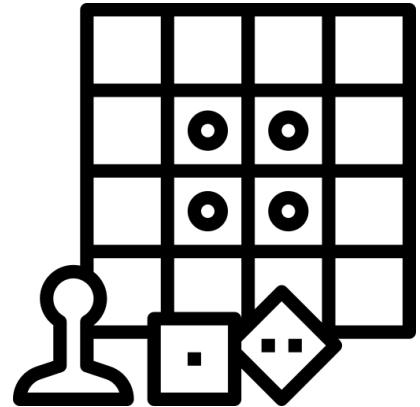
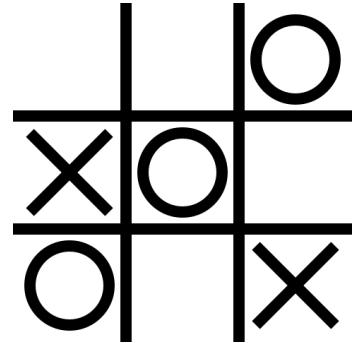


Not all play is a game but play is
necessary for having a game.

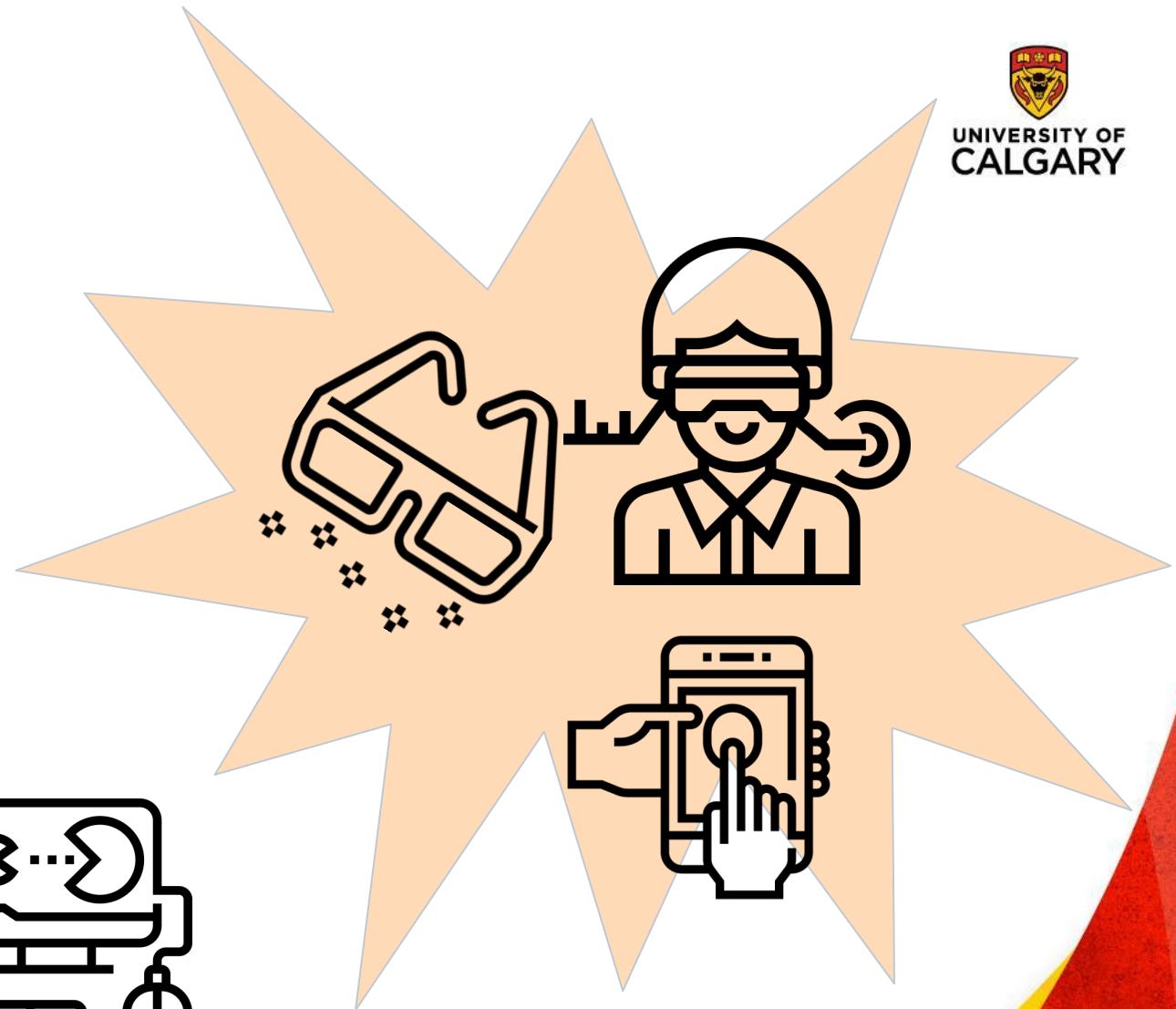
What are Games?



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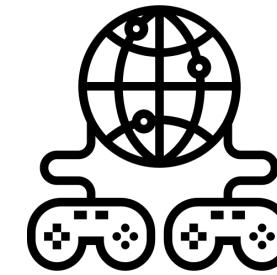
[Arcade Archive](#)



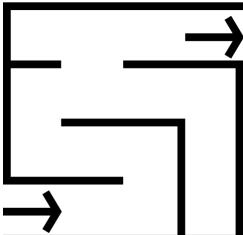
What are Games?



Collaborative, multispace and multimedia (USC Art)
<https://cinema.usc.edu/interactive/index.cfm>

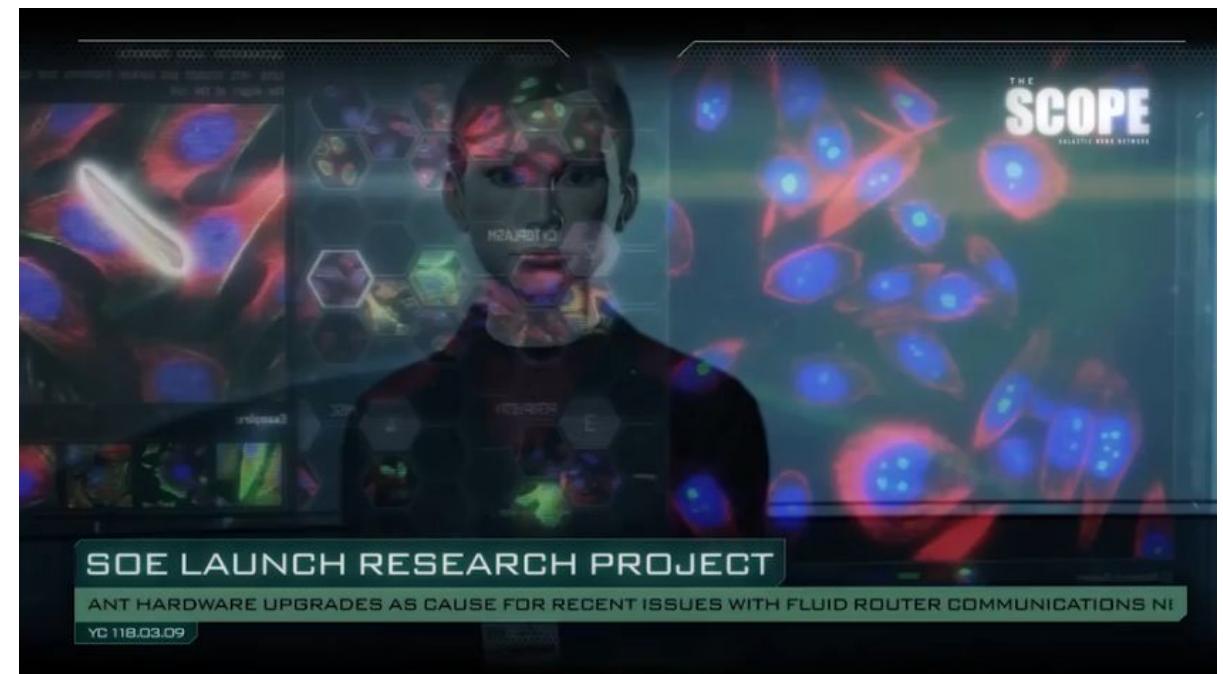


Massive Multiplayers Online Games (MMOs)



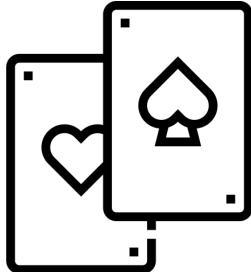
Escape Rooms (UCalgary)

[UCalgary Chemistry Escape Room](#)
[UCalgary STEM Escape Room](#)



[Eterna](#), [Project Discovery](#), [ICED](#)

What are Games?



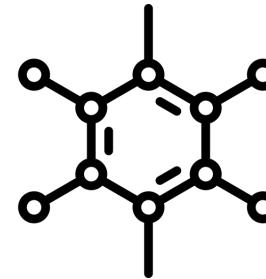
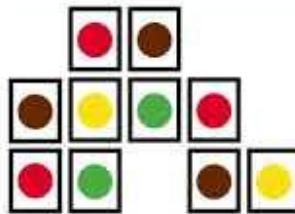
Card games

UBC → <http://phylogame.org/>

ACTIONS

- ▶ **PLAY**
- ▶ **MOVE**
- ▶ **DROP**
- ▶ **PASS**

Basically like **dominoes**... but not all adjacent cards need to be compatible! Only need one path back to an autotroph.



Augmented Reality

CRI in partnership with Theoretical Biochemistry Lab (CNRS) Paris, France



<http://beatymuseum.ubc.ca/visit/gift-shop/phylo-card-game/>

<https://collectifblueprint.itch.io/pangu>

Facts about Games

- Games are **voluntary** you can't impose them
- Something you may want to do in your **free time**
- They have **goals** and we **learn** through them
- Are part of any **culture** and we **share human experience** through them
- We **engage** in games when they are **FAIR** (rules) and **FUN** (interactive, challenge, rewards, surprises, conflict, cooperation)
- They have an **outcome**
- Games embody the vision of something fun providing opportunities for “reflectively exploring phenomena, testing hypotheses and constructing objects” (Kiili, 2005, p.14)

Kiili, K. (2005). Digital game-based learning: towards an experiential gaming model. *Internet and Higher Education*, 8(1), 13–24.
<http://doi.org/10.1016/j.iheduc.2004.12.001>

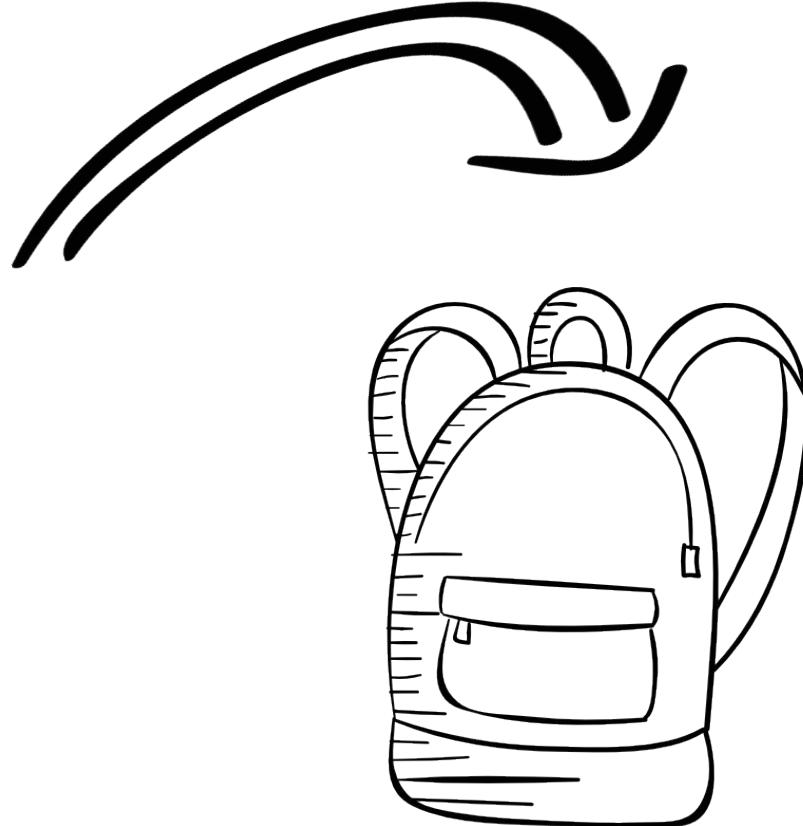
Salen, K. and Zimmerman, E. (2003). *Rules of Play: Game Design Fundamentals*. MIT Press. (ISBN: 9780262240451)
Schell, Jesse. *The Art of Game Design, A Book of lenses*. 2nd Edition, 2014, Carnegie Mellon University.



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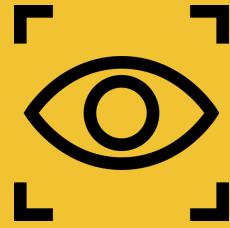
Goals for Today

- Learn game design principles and tools to build a basic game.
- Design and prototype a simple game based on learning outcomes.



Have Fun Playing and Learning!

How? → Activity Plan for Today



Game-based Learning Showcase
Case Study



Design and Prototype a Game
Play-Create-Share

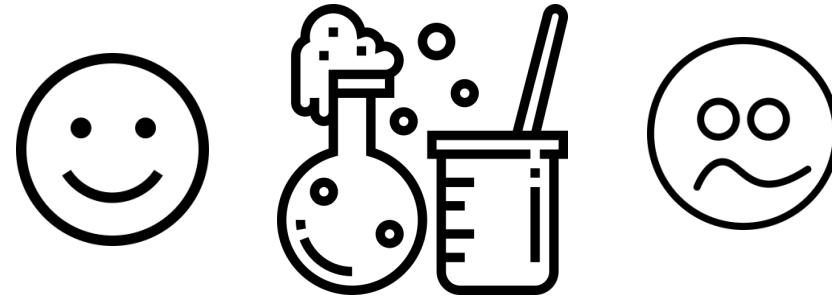


Teach with a Game
Brainstorm

Game Definition

“System in which players engage in a **challenge** defined by **rules**, **interactivity** and **feedback**, that results in a quantifiable **outcome**, often creating an **emotional reaction**”

Adaptation of Definition in: [Rules of Play: Game Design Fundamentals \(MIT Press\)](#), Chapter 7: Our Definition.



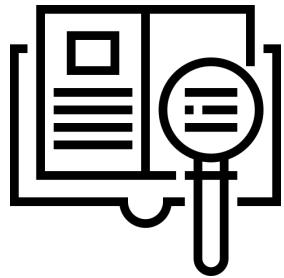
“A game is a problem-solving activity, approached with a playful attitude”

[The Art of Game Design, A Book of lenses](#). Jesse Schell, Carnegie Mellon University. Chapter 3, pg. 37.

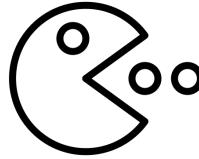
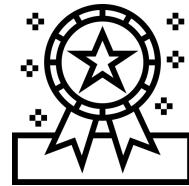
Games and education: Beyond entertainment?



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distinction between “**gamification**” and “**game-based learning**.”



Learning by replacing grades with levels and merit badges; or, rather than delivering lectures and then testing for retention, teachers create project-based units where completion, or the demonstration of mastery, is what allows the student to move on.

Using actual games / digital video games as a classroom tool to enhance, amplify and transform learning.

Want to learn more?

Games and education: Beyond entertainment?

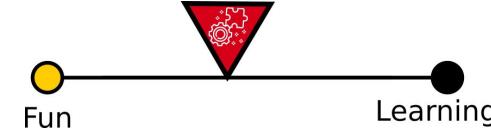


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Serious games



Game Goal

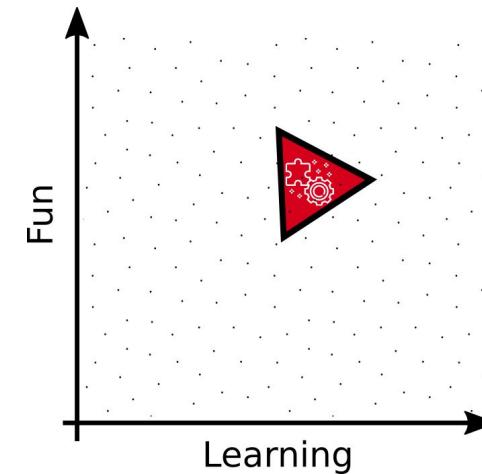


"Experimental and emotional freedom of active play"



"Seriousness of thought and problems that require it"

Abt, C. A. 1970. *Serious games*. Viking, New York.



Purpose driven playful environments intended to impact the players beyond the self-contained aim of the game. ***Entertainment alone is not their paramount goal.***

[SGDA Framework, Migutsh K. and Alvarado, N., 2013.](#)

Why?

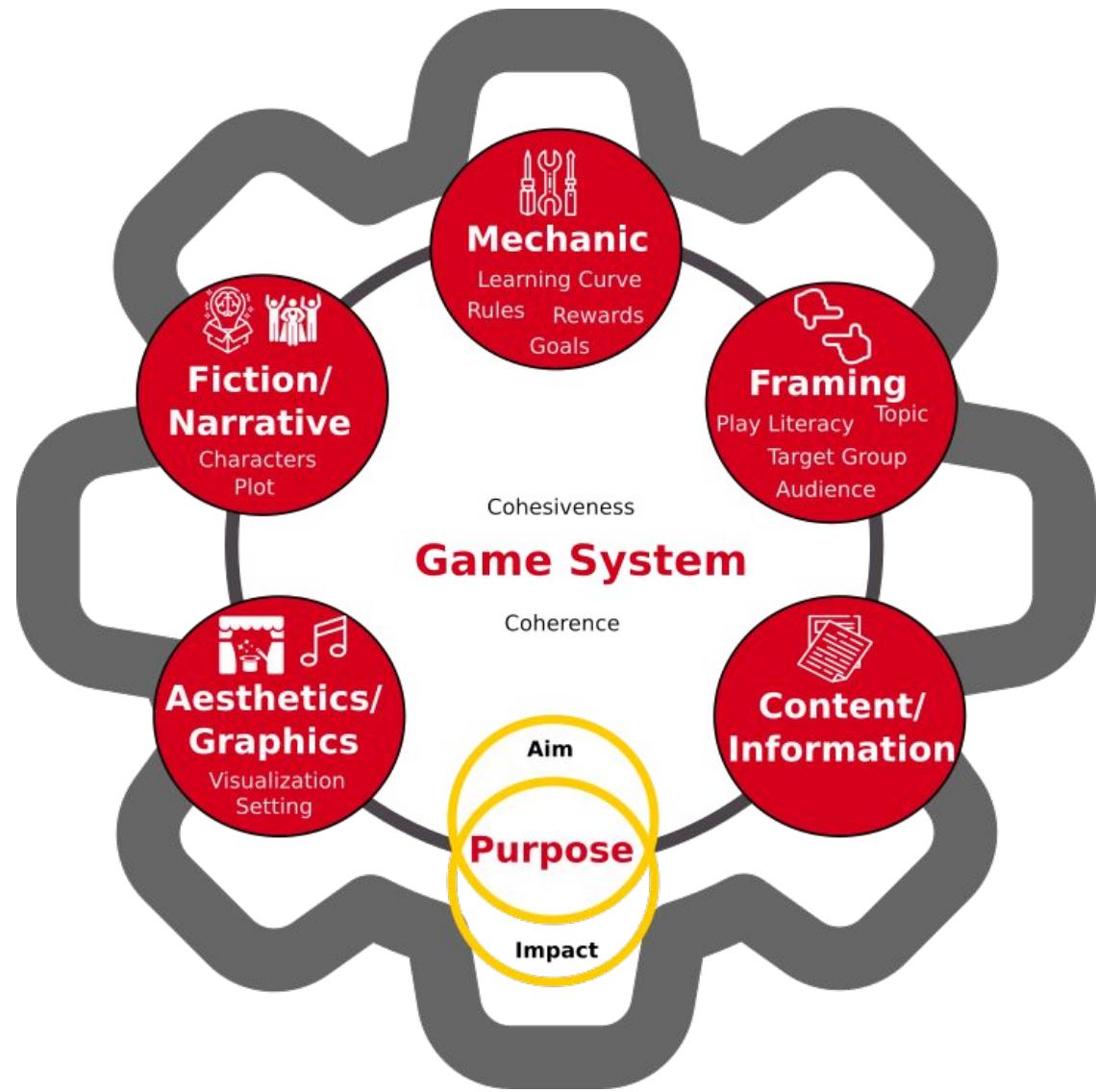
Games as Teaching and Learning Tools

- Provide a different approach to developing metacognitive skills through persistent self-reflection and iteration of particular skill sets.
- Offer experiential contextualized learning through real interaction and/or virtual simulation.
- Offer an especially engaging interdisciplinary learning space.
- Richer and Dynamic assessment.

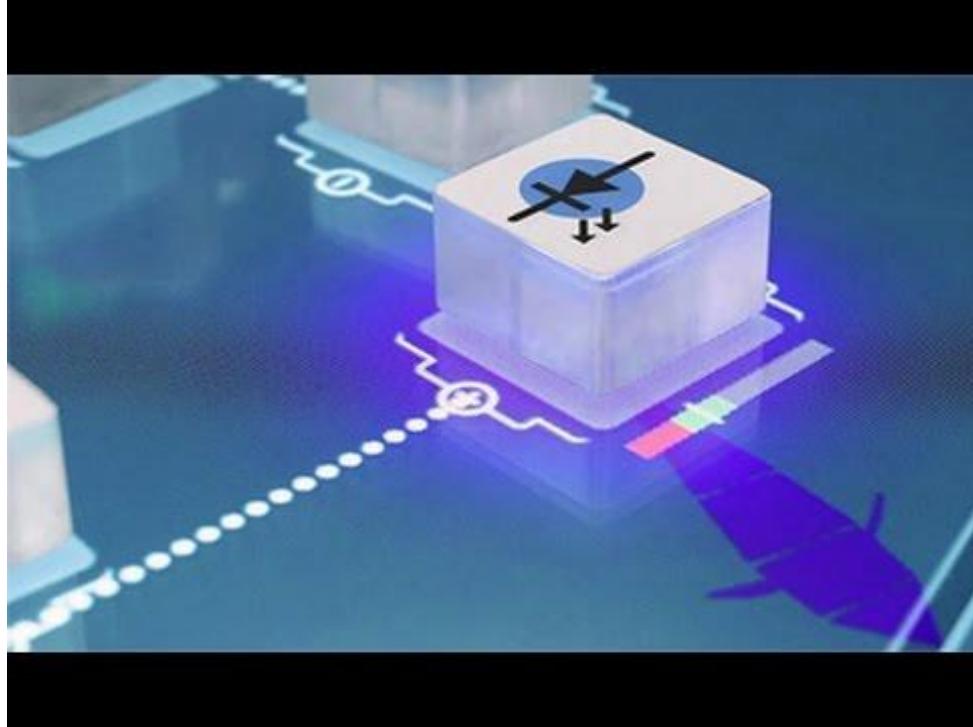
“Games are problem solving spaces”

Games and education: Beyond entertainment?

Serious games Design Assessment Framework



!

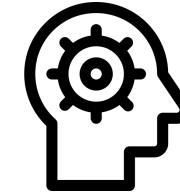


MIT Game Lab

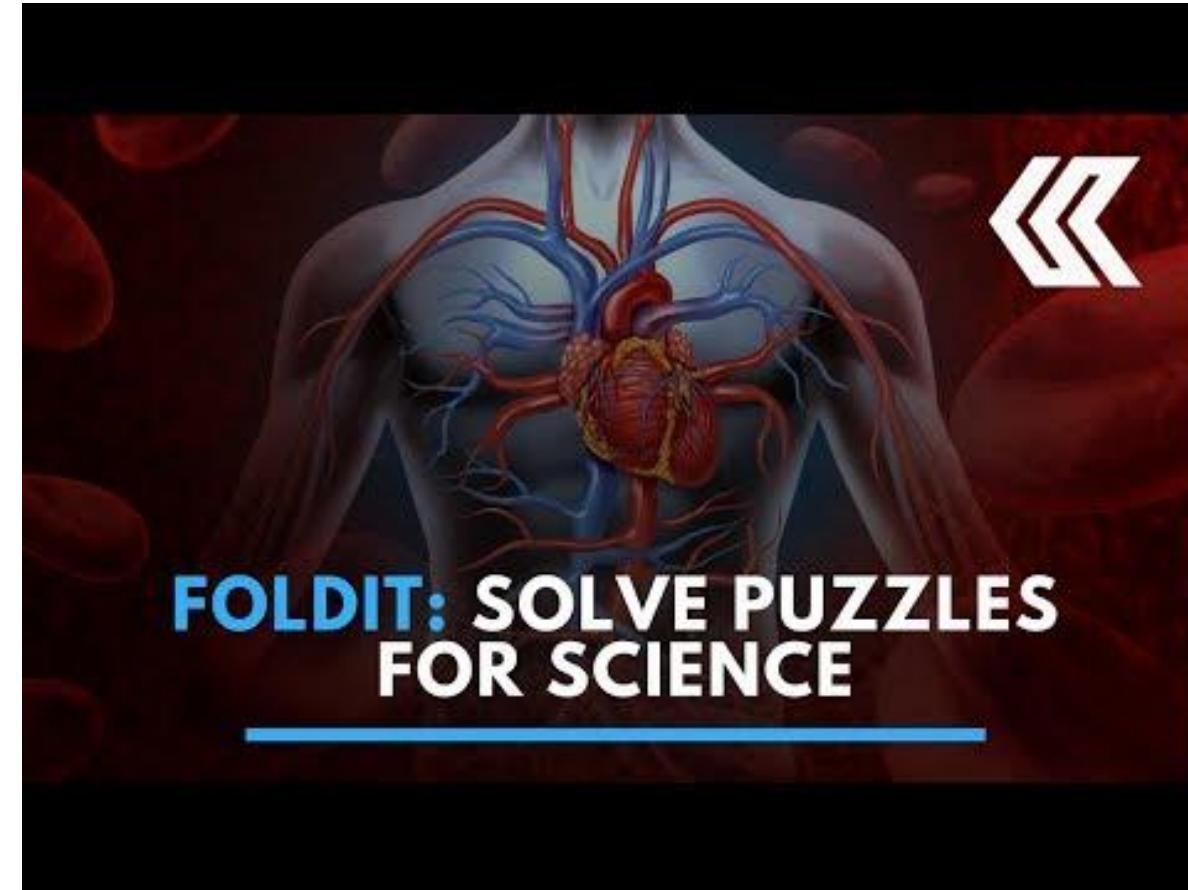
Game Design



Click on to see the assessment framework



PLAY Foldit



Han, E. Citizen Science:People Power | [Nature 466, 685-687 \(2010\)](#) | doi:10.1038/466685a

Dsilva, L. et al. Creating Custom Foldit Puzzles for teaching Biochemistry. [Biochemistry and Molecular Biology Education, 2019, 1-7](#). doi.org/10.1002/bmb.21208

Horowitz, S et. al. Determining crystal structures through crowdsourcing and coursework | [NATURE COMMUNICATIONS, 2016 | 7:12549](#) | DOI: 10.1038/ncomms12549

Franco, J. Online Gaming for Understanding Folding, Interactions, and Structure. [J. Chem. Educ., 2012, 89 \(12\), pp 1543–1546](#). DOI: 10.1021/ed200803e

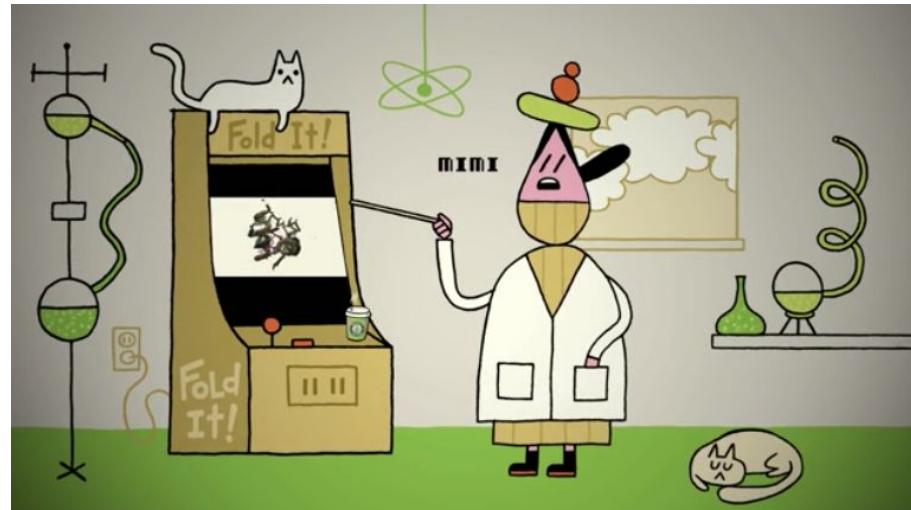


What players say...

And that is a good enough motivation for Zaccanelli. “Maybe something I do will help contribute an answer to curing cancer or AIDS or the common cold,” he says. ■

Eric Hand is a reporter for *Nature* in Washington DC.

Han, E. Citizen Science: People Power | [Nature 466, 685-687 \(2010\)](#) | doi:10.1038/466685a



Mycobacterium tuberculosis, and anthrax. The response from the students was very positive, as it gave them hands-on experience of identifying key factors in determining a protein’s structure as well as visualizing protein structures and their interactions. The ability to work on “real-world problems” significantly increased students’ interest in the assignment. Incorporating Foldit into the course curriculum increased student engagement and comprehension of the material.

Franco, J. Online Gaming for Understanding Folding, Interactions, and Structure. *J. Chem. Educ.*, 2012, 89 (12), pp 1543–1546. DOI: 10.1021/ed200803e

“We think this is a big deal because interpreting an electron-density map can be a labor-intensive, error-prone process—and we show that crowd-sourced Foldit players can do it as well as, or better than, professionally trained crystallographers,” said graduate student Brian Koepnick of the University of Washington Institute for Protein Design.

Horowitz, S et. al. Determining crystal structures through crowdsourcing and coursework | [NATURE COMMUNICATIONS](#). 2016 | 7:12549 | DOI: 10.1038/ncomms12549
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2956414/>

"I've seen how much players learn about proteins from playing this game," "We spend weeks and weeks trying to jam this into students' brains and Foldit players learn it naturally because it's fun."

Professor Scott Horowitz at the University of Denver

Case Study

Activity 1



Game over for aflatoxin



Making food safer together. We are crowdsourcing solutions to battle aflatoxin through Foldit - a revolutionary online game



Aflatoxin-round1
(Oct, 2017)

Aflatoxin-round12
(Nov. 2018)

Games and Education: Genres of Games

- **Puzzlers:** pattern recognition ([Foldit](#), [Phylo](#), [Bioblox](#), [Zoombinis](#))
- **Drill and Practice** games ([mathblaster](#), [ReflexMath](#), [PhET](#))
- **Strategy Games** ([Civilization](#))
- **Role Playing** games: Missions ([Project Discovery](#), [InCell](#))
- **Sandbox Games** ([minecraftEd](#)) open creative virtual space with shovels
- **Design your own game** ([Gamestar Mechanics](#))



Click on to discover Zoombinis

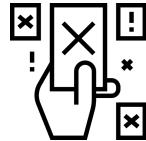


Games and education: 4 Freedoms to PLay

- Explore



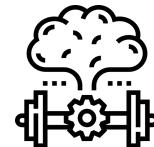
- Failure

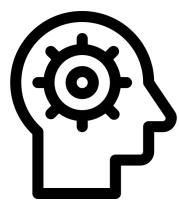


- Identity



- Effort

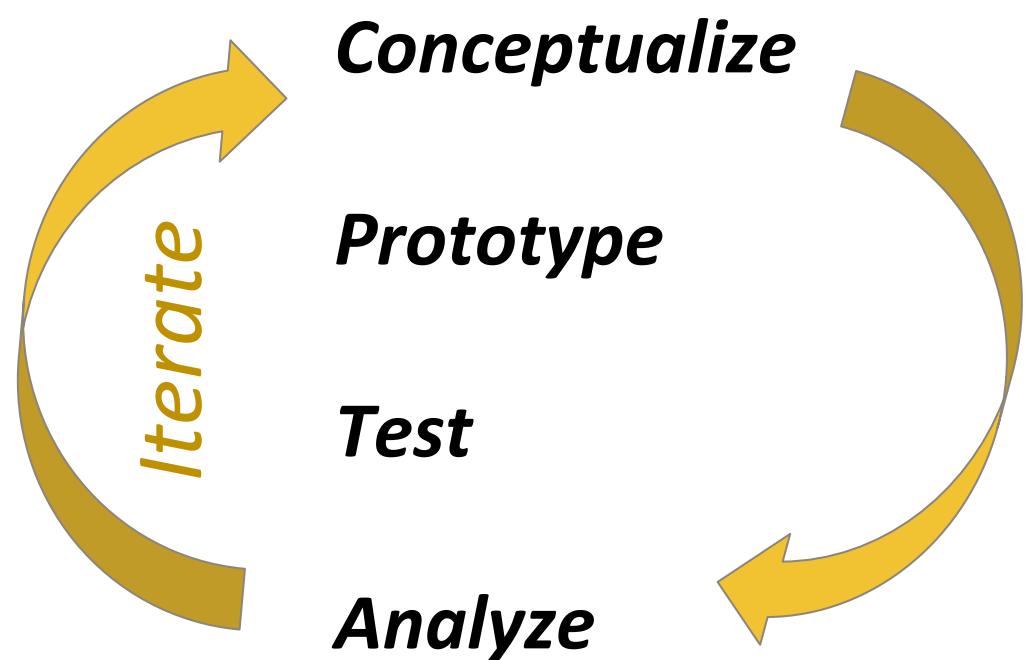




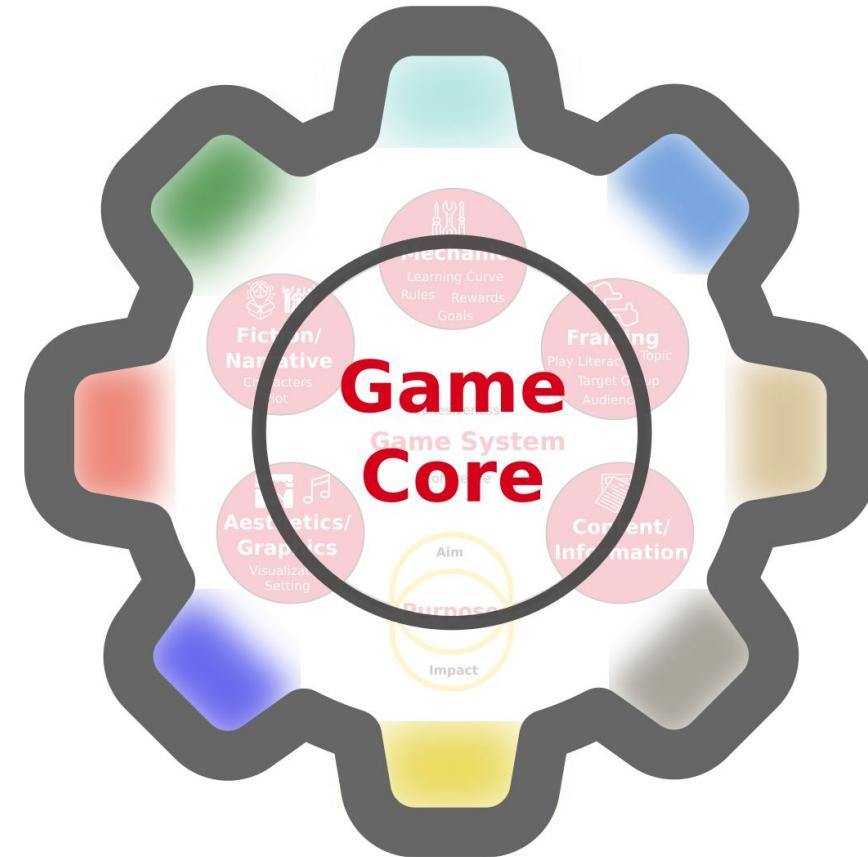
Design and Prototype a Game

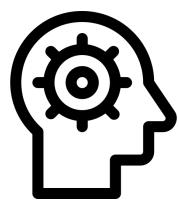


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- Game Core: Elements of a Serious Game





Design and Prototype a Game

Keep in mind!

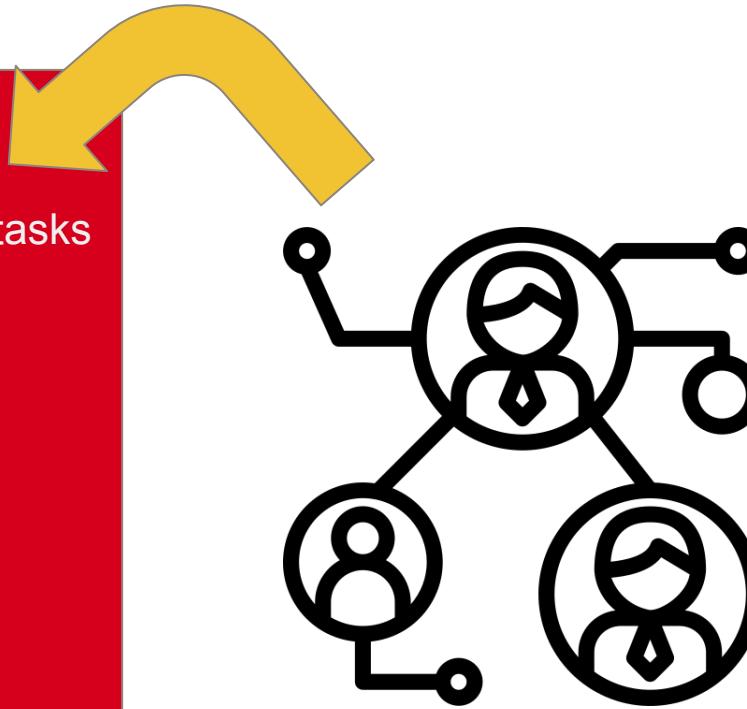
- Make the first prototype as simple as possible
- Prototypes should have a reason for existing, use version control/ version track
- Share the prototypes (use forums, get feedback from players)
- Don't forget to think about whether your players are learning!



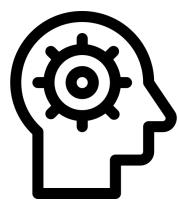
Design and Prototype a Game

Ten rules to design a serious game

- 1-Define a (serious) goal
- 2-Fine tune balance between entertainment and serious tasks
- 3-Enable the player to interact with data
- 4-Promote onboarding and engagement
- 5-Manage information flow
- 6-Provide appropriate narrative
- 7-Adapt your level design
- 8-Develop good graphics
- 9-Use all modalities, particularly sound

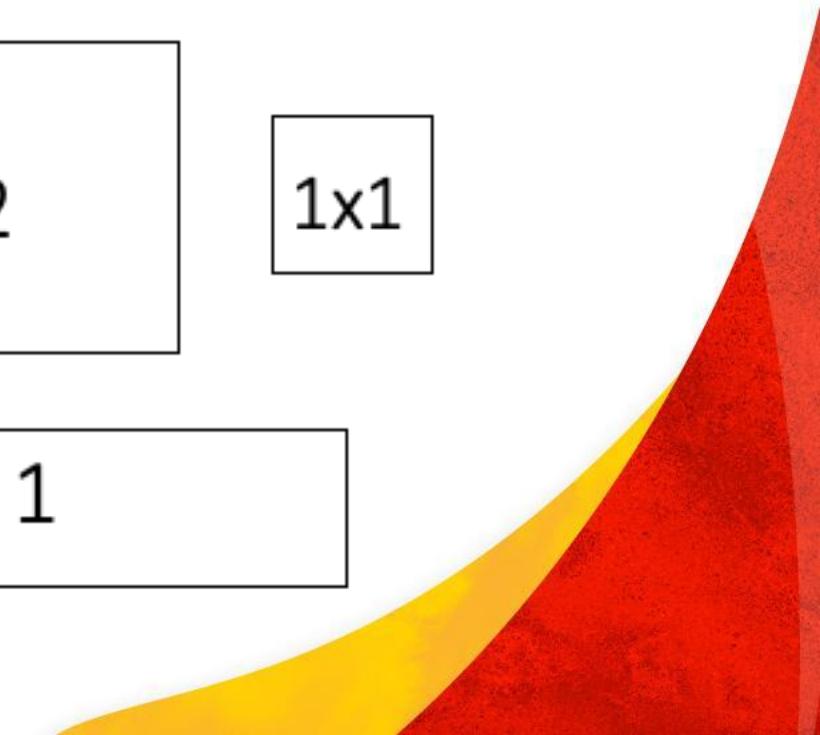
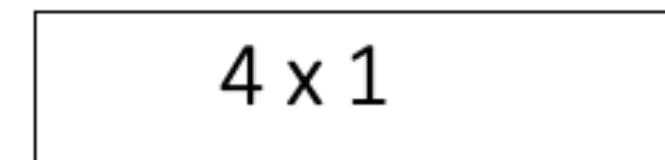
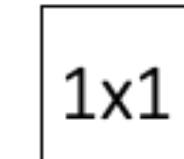
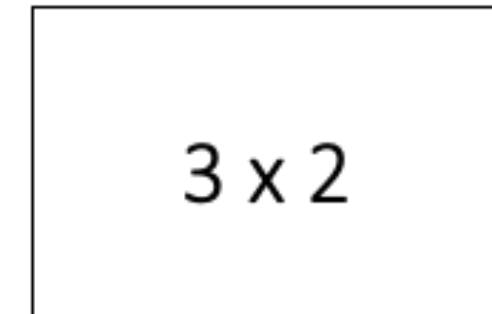
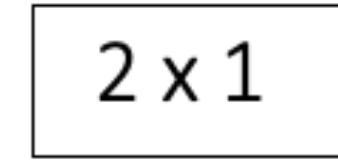
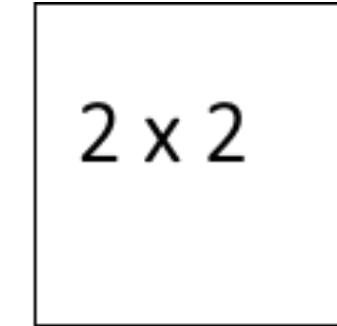
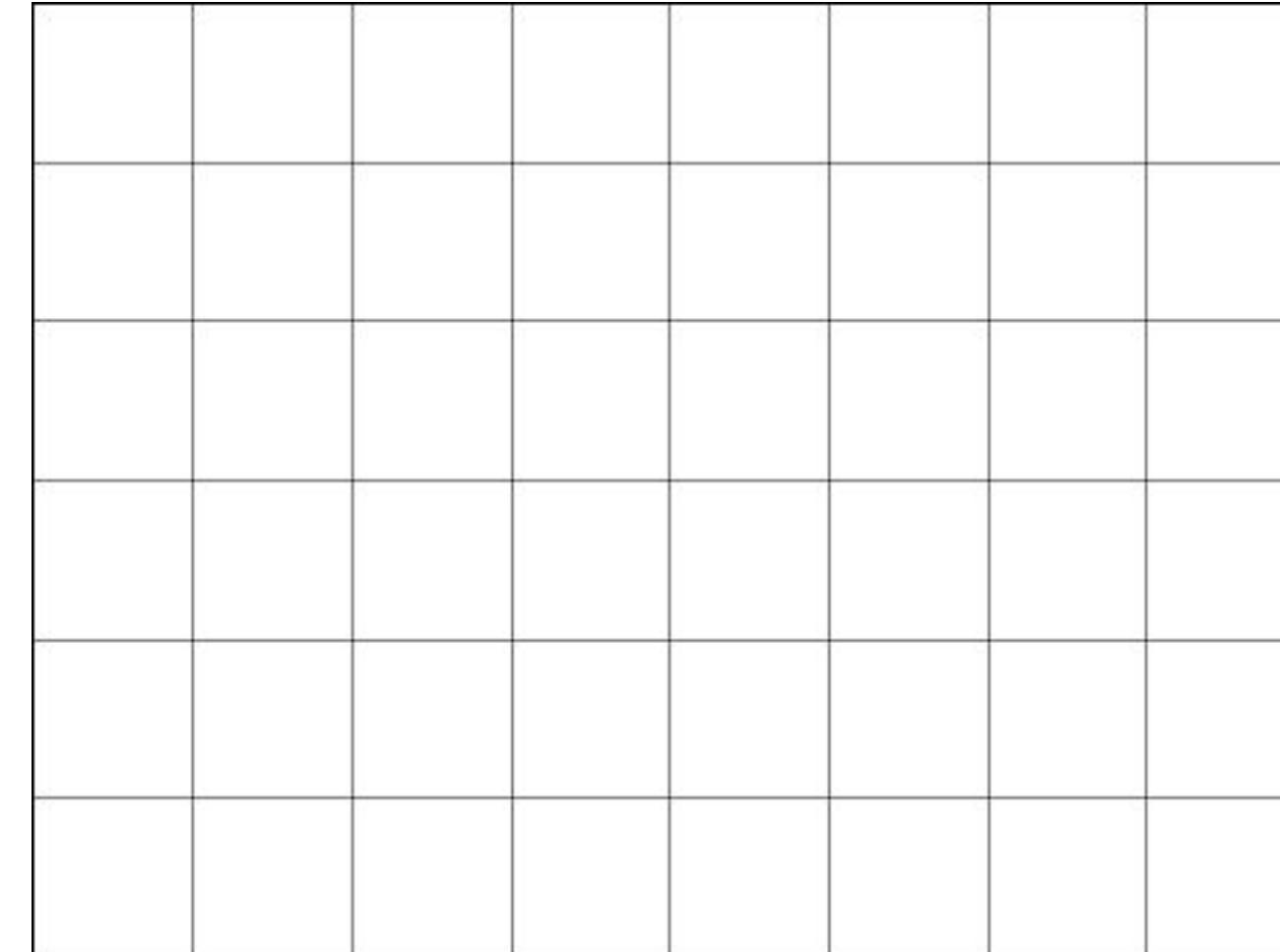


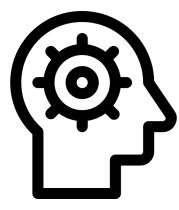
10-Iteratively assess what works and what doesn't



Design and Prototype a Game

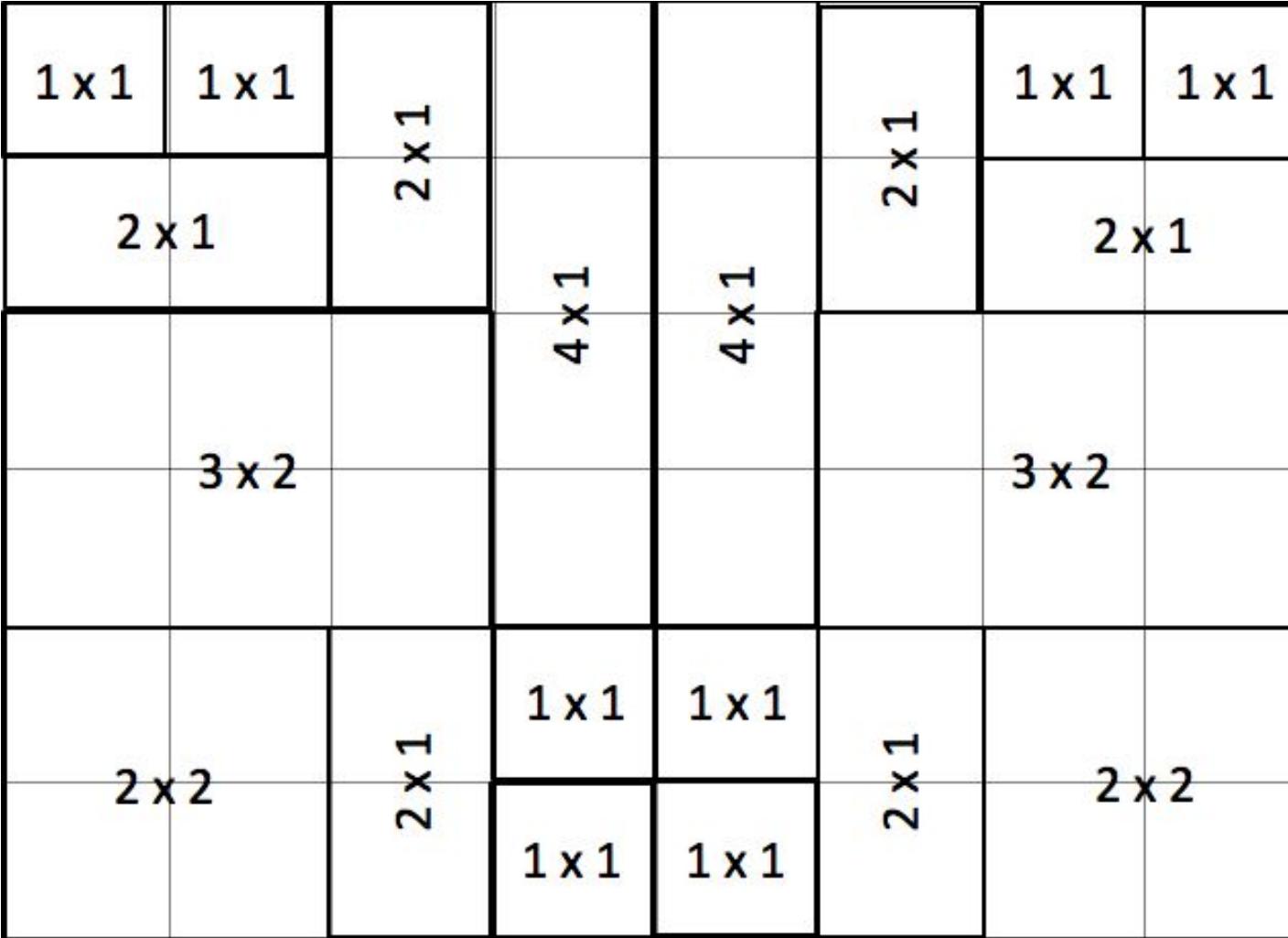
General Example -Puzzle Game-

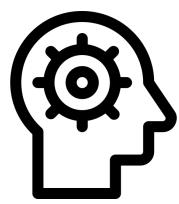




Design and Prototype a Game

General Example -Puzzle Game-



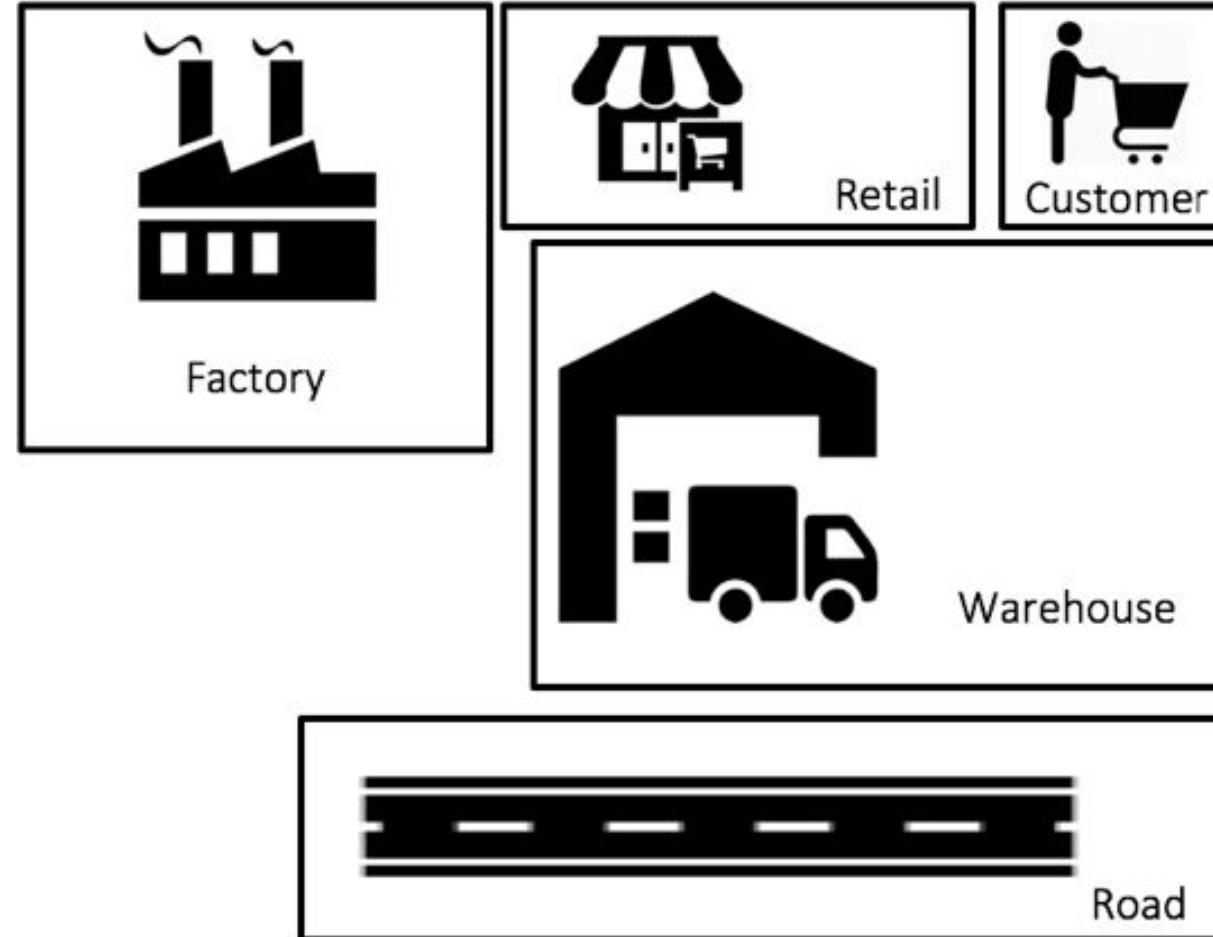


Design and Prototype a Game

Business Supply Chain Example

Supply chain management (SCM)

Is the broad range of activities required to plan, control and execute a product's flow, from acquiring raw materials and production through distribution to the final customer, in the most streamlined and cost-effective way possible.



Game Goal: identify the components of the chain and connections between them in order to design, plan and execute an effective flow.



Design and Prototype a Game

Business Supply Chain Example

Play time



Game Rules:

- 1) Fill every block on the board
- 2) These conditions must be met:

1 Factory – 1 Warehouse (min.)

1 Warehouse – 3 Retails (min.)

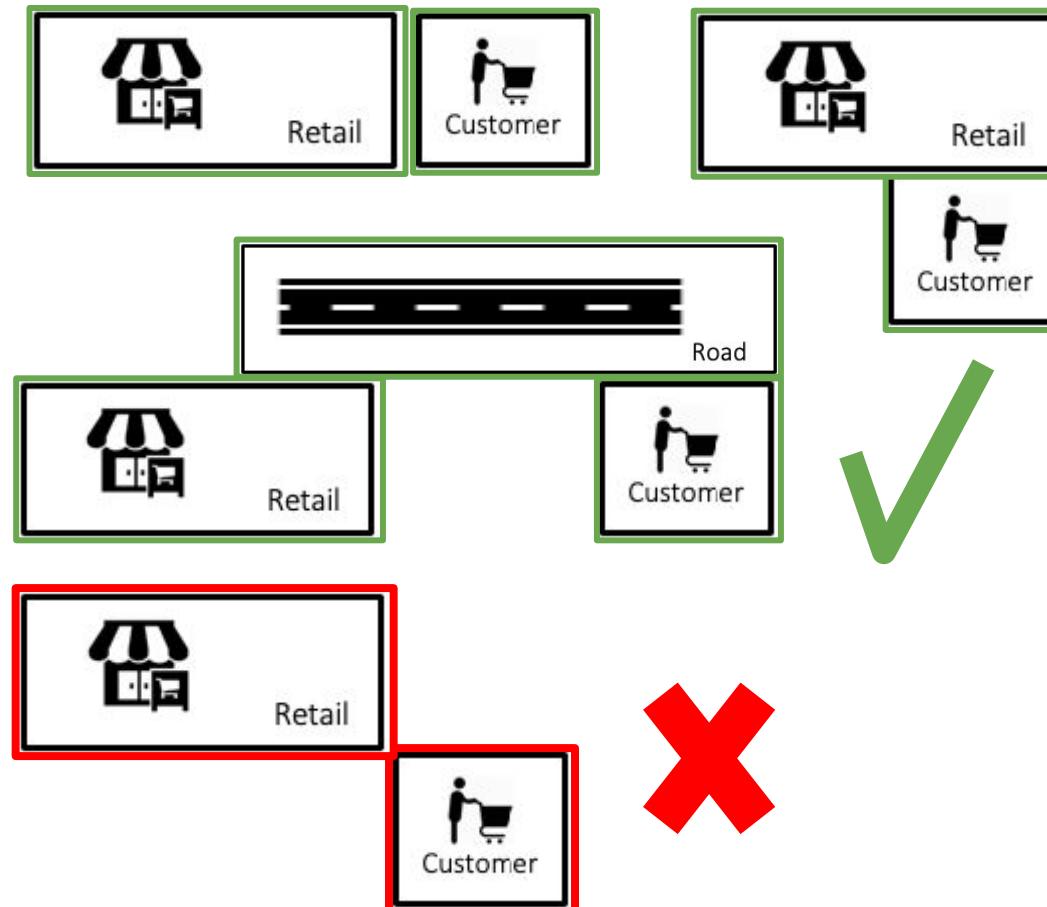
1 Retail – 2 customers (min.)

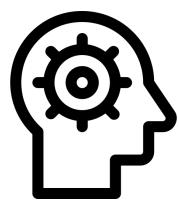
Use 1 road at least

Constraints:

-**Types of Connections (valid for all pieces):** Adjacent connections are allowed, or they may be connected by a road.

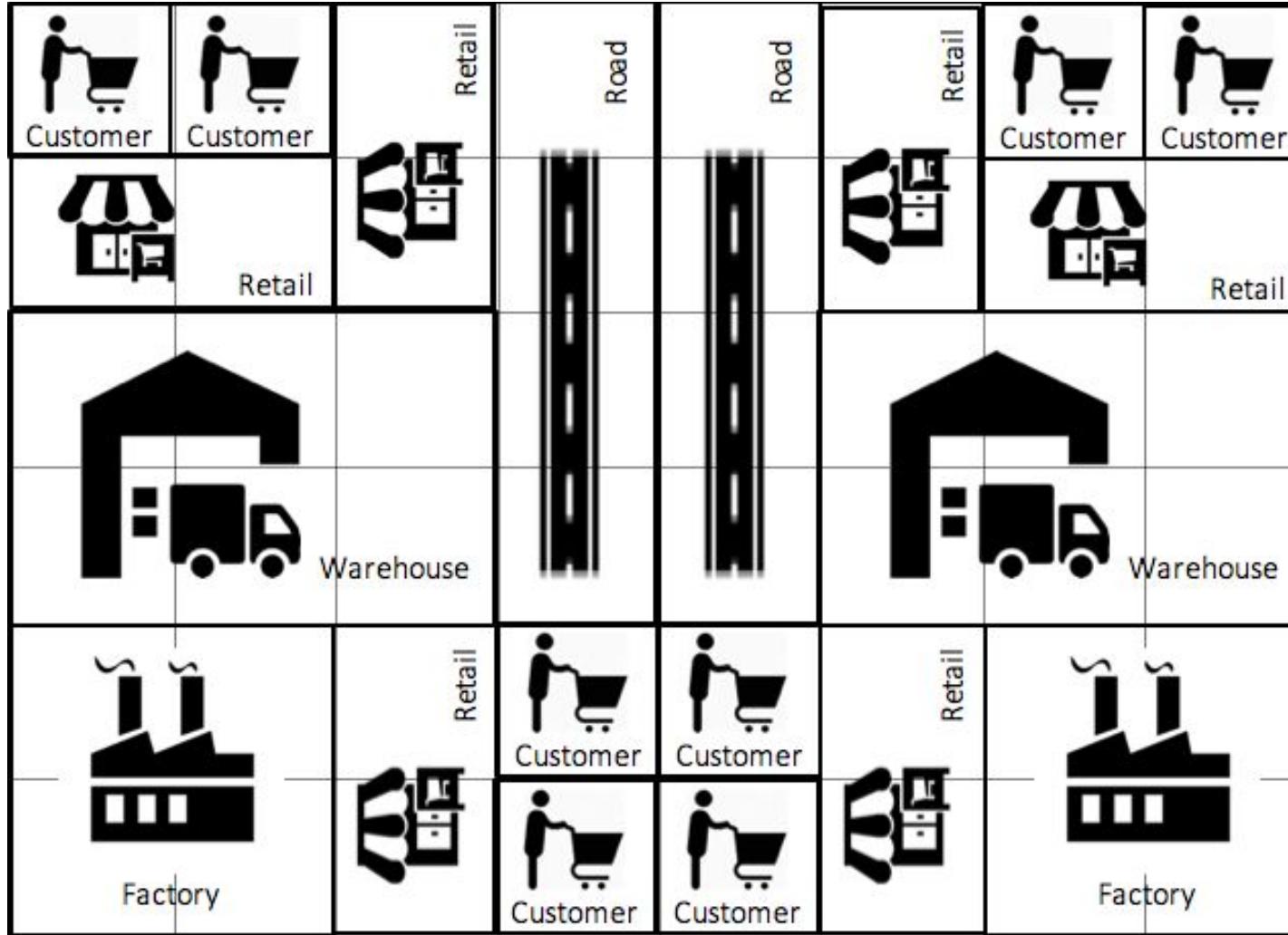
Examples:





Design and Prototype a Game

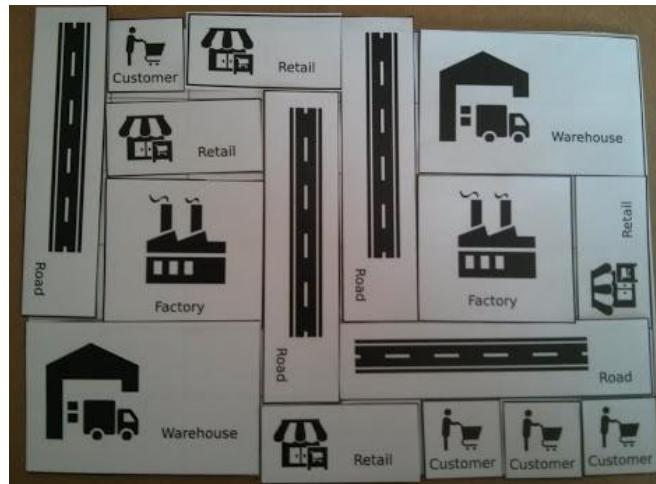
Business Supply Chain Example Solution



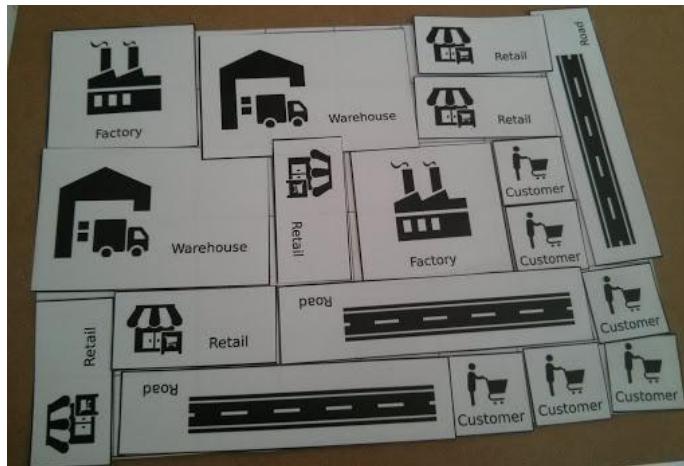


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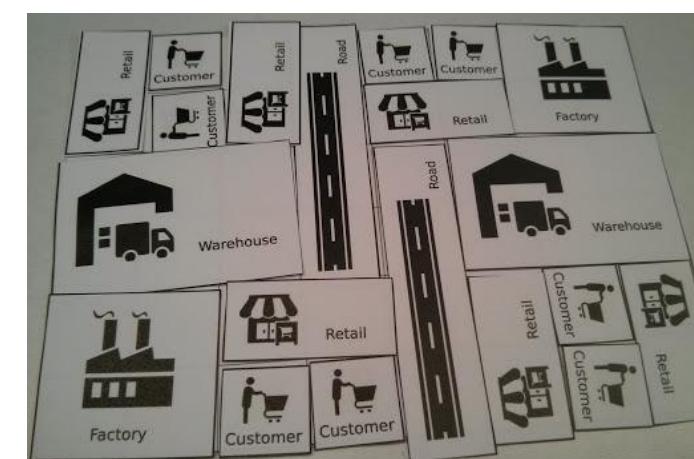
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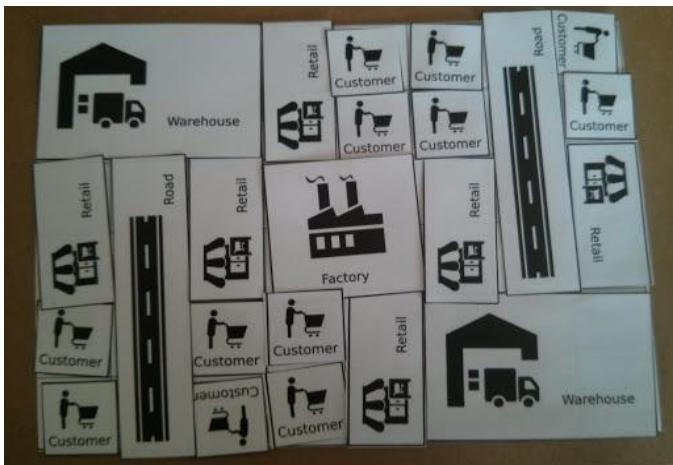
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3



4

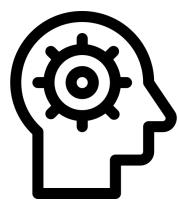


5



6

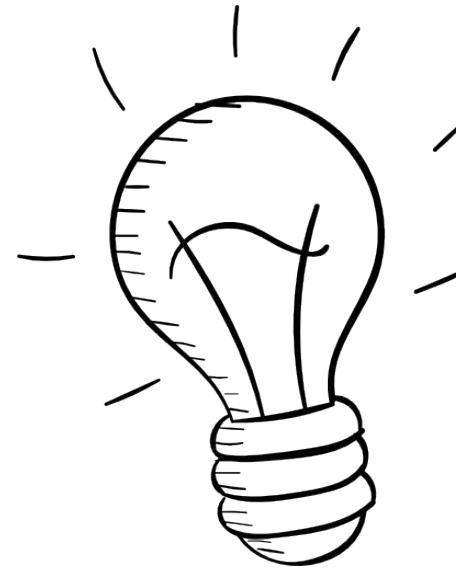




Design and Prototype a Game

Ideas for game modification

- Add a dice roll element
- Add a competition
- Increase number of players
- Add an obstacle in the grid
- Add points
- Add money in the game





Design and Prototype a Game

Design your own game

- 1-Use the template sheet and discuss elements of the game, **what would you change?**
- 2-Choose a domain of knowledge
- 3-Modify Business Supply Chain Game
- 4-Consider: block theme, costs, mechanics, etc.





Activity 2

Share

Design and Prototype a Game

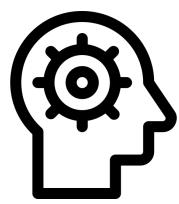
Design your own game



Present your idea/prototype

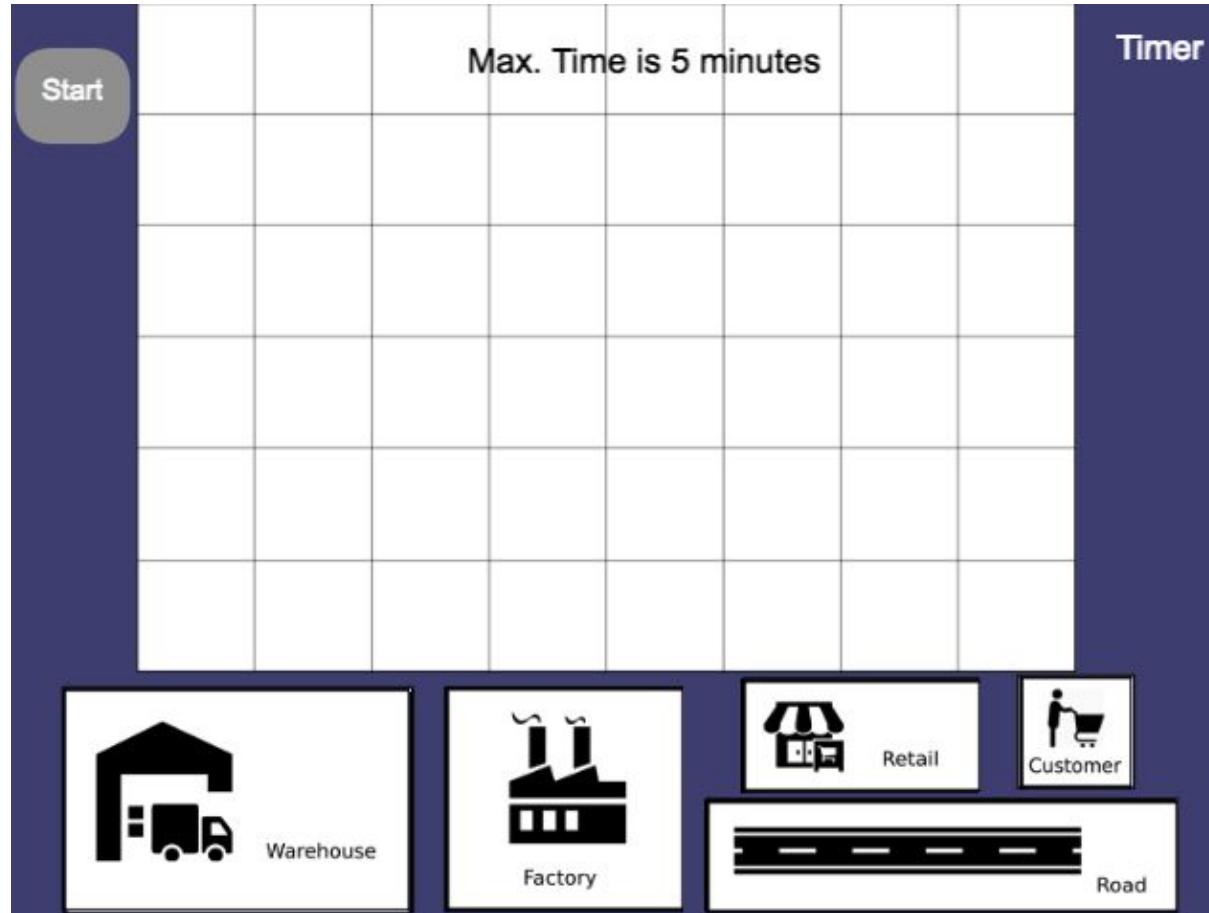


- What are you learning as you create the game?
- What does your game teach as it is being played?

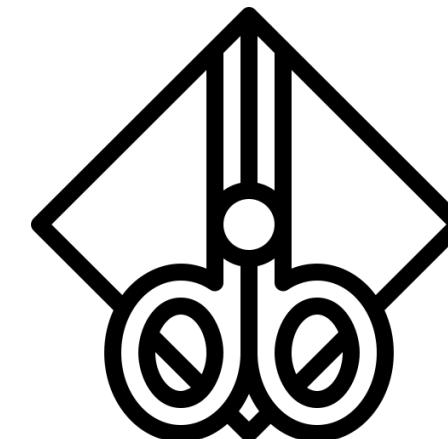


Design and Prototype a Game

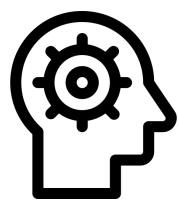
Tools to develop games and prototypes



<https://unity3d.com/learn/tutorials/modules/intemediate/live-training-archive/prototyping-standard-assets>



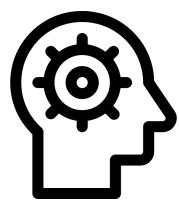
<https://www.sketchbox3d.com/>



Design and Prototype a Game



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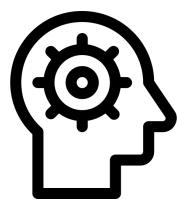


Design and Prototype a Game



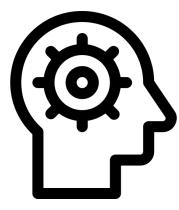
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Design and Prototype a Game

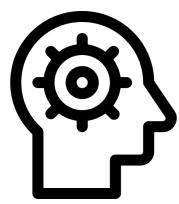




Design and Prototype a Game



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Design and Prototype a Game



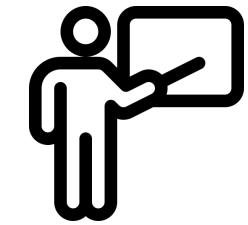
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2018 International Business Learning Games Competition



6th International Educational Game Competition at EGBL 2018



Teach with a Game

How would you teach something with a game that already exists or you have created?

- **Who** are your students?
- **What** do you want them to learn? What are the content, skills, ideas you want them to come away with?
- **Why** this game? What aspects of a game make it an excellent fit? What features?
- **How** are you implementing the game? Before instruction, as a thought starter, in-class competition, extra credit, enrichment...
- **Where** are students playing the game? What is the context? At home, classroom, individually, phone...



Teach with a Game

What criteria matter when considering learning games?

1- First, ask the **broad questions**: How and when a game can be used?

- Short, long, individual, collective, inside/outside classroom
- Are you comfortable?
- Assess your resources

2- Then, be **more specific**: What kind of game is best suited to particular learning objectives?

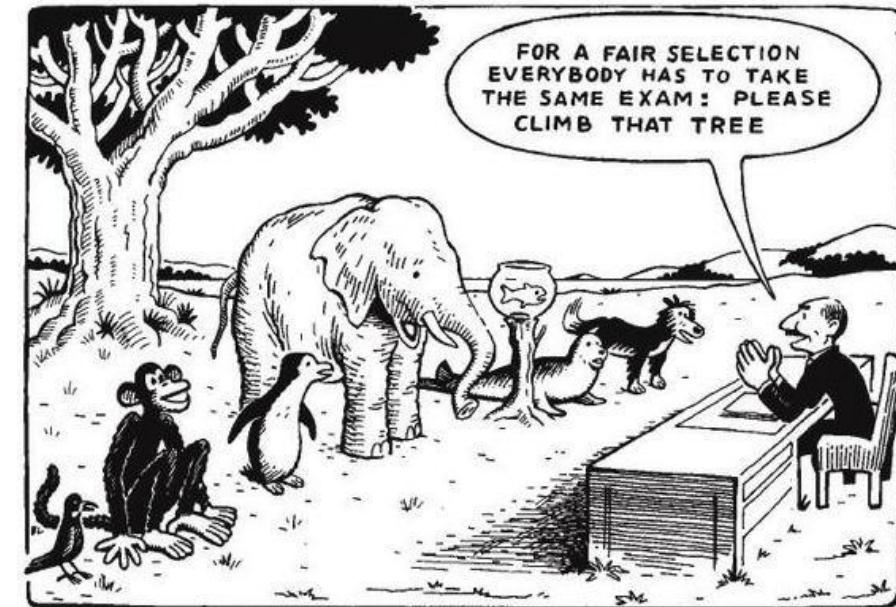
- Mechanics: rules, structures

Teach with a Game: Decision and Obstacles



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- Insufficient time
- Cost
- Lack of tech resources
- Hard to find games that fit the curriculum
- Effective Integration
- ***Emphasis on standardized exams***





Reflect... How are you going to use Games?

How are games going to be implemented so they effectively enhance and transform learning?



Welcome Students!

Instructors' Best Practices!

Franco, J. *Online Gaming for Understanding Folding, Interactions, and Structure.* [J. Chem. Educ., 2012, 89 \(12\), pp 1543–1546](#). DOI: 10.1021/ed200803e



Reflect... How are you going to use Games?

How are games going to be implemented so they effectively enhance and transform learning?

- Not an assignment, not as homework!
- Use games to trigger curiosity, so they are played voluntarily.
- Follow game design recommendations so the game has all the elements to make it successful.
- Offer authentic and meaningful rewards.

Resources



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Contact Us!

<https://taylorinstitute.ucalgary.ca/>

Software

University Software Distribution: A variety of software is available to members of the university community. The software license agreement between the vendor and the University of Calgary will determine whether the software can be installed on university-owned computers (managed or unmanaged) or a person's personally-owned computer. For more information please visit:

<https://iac01.ucalgary.ca/SDSWeb/>

Game Creation and Prototyping

Gameblox: <https://gameblox.org/>

Gdevelop: <https://gdevelop-app.com/>

Unity Game Engine / Game Editor Software:
<http://unity3d.com/unity/download>

Unity Learning Materials and References:

- Self-Study Learning Materials <http://unity3d.com/learn>
- Unity Online Docs and Technical Manuals:
<http://docs.unity3d.com/Manual/index.html>

Unity Game Assets and Program Extensions: Access to a huge assortment of texture, sounds, models, shaders. program extensions and more.

<https://assetstore.unity.com/>

Unity for Educators and Academic Institutions:
<https://unity.com/education>

Image Editing

Adobe Photoshop (UCalgary licensed software)
Gimp (free): <https://www.gimp.org/>

Graphics Editing & Design

Inkscape (free): <https://inkscape.org/>
Adobe Photoshop, Illustrator, Spark (UCalgary licensed software)
Autodesk 3ds Max:
<http://www.autodesk.com/education/free-software/3ds-max>

Animation Software

PowToon (free online web-based):
<https://www.powtoon.com/home/>
Blender (free): <https://www.blender.org/>
Adobe Animate, After Effects (UCalgary licensed software)
Google SketchUp: <http://www.sketchup.com/>

Audio Assets

Free Sound Effects: <http://www.freesoundeffects.com/>

Educational Games Resources

Digital Games

<https://www.sciencegamecenter.org/>
Various Games Repository: <http://www.gamesforchange.org/>
Polycraft (petrochemical refining, polymers):
https://polycraft.utdallas.edu/index.php?title=Main_Page PhET (chemistry):
http://phet.colorado.edu/sims/html/balancing-chemical-equations/latest/balancing-chemical-equations_en.html
ACS (chemistry):
<https://www.acs.org/content/acs/en/education/whatischemistry/adventures-in-chemistry/games/outer-space-molecule-chase.html>
<https://www.acs.org/content/acs/en/education/whatischemistry/adventures-in-chemistry/games/bugs-on-the-run.html>
Urban Planning & Climate change: <http://futuredelta2.ca/>
<https://evewire.org/explore>
Polymorph (drug design):
http://polymorph.fr/software/?lens_portfolio=doc-molecules-2&lang=en
Safety:
<https://www.edx.org/course/lab-safety-interactive-game-dont-ricex-labsafety-1x-0>

Escape Rooms

<https://www.breakoutedu.com/tutorials>
<https://lockpaperscissors.co/school-escape-games>
<https://www.theescapeclassroom.com/>
<https://askabiologist.asu.edu/training-room-game/index.html>
<https://www.ucalgary.ca/utoday/issue/2018-09-21/escape-room-experience-captures-fun-side-chemistry>
https://www.ucalgary.ca/chem/files/chem/event-poster_fos-branded_chemescape2018.pdf
<https://askabiologist.asu.edu/training-room-game/index.html>

Game Apps

Biogames:<https://itunes.apple.com/gb/app/incell-vr-cardboard/id1044805956?mt=8>
<http://www.bioblox.org/>
<https://play.google.com/store/apps/details?id=rmit.edu.au.oliverjone&hl=en>
pangu: <https://www.youtube.com/watch?v=8ZfiphFR7CE>
Nitap (Indigenous stories game):
<https://www.cbc.ca/news/canada/new-brunswick/app-traditional-indigenous-stories-1.4616265>

Linkedin Learning (free access for UCalgary staff member and faculty):

<https://www.ucalgary.ca/hr/linkedIn-learning>

EdX Courses:

https://www.edx.org/course/design-development-games-learning-mitx-11-127x-0?utm_source=sailthru&utm_medium=email&utm_campaign=triggered_shareit

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<https://library.ucalgary.ca/copyright>

Selected Literature



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Baaden, M. et al. Ten simple rules to create a serious game, illustrated with examples from structural biology. *PLOS Computational Biology* | March 8, 2018. <https://doi.org/10.1371/journal.pcbi.1005955>

Baron, S. Cognitive flow: the psychology of great game design. *Gamasutra*, 2012; <http://go.nature.com/2gk6PKW>

Connolly, T. M. et al. A systematic literature review of empirical evidence on computer games and serious games. *Computers and Education*, 2012, 59, 661-686. <https://doi.org/10.1016/j.compedu.2012.03.004>

Han, E. Citizen Science: People Power | [Nature 466, 685-687 \(2010\)](#) | doi:10.1038/466685a

Kafai, Y. B. (2006). Playing and making games for learning: Instructionist and constructionist perspectives for game studies. *Games and Culture*, 1(1), 36–40.

Kwok, R. (2017). Game On. *Nature*, 547, 369–371. <http://doi.org/10.1038/nj7663-369a>

Migutsh K. and Alvarado, N, Purposeful by design?: a serious game design assessment framework. *Proceedings of the International Conference on the Foundations of Digital Games*. Pages 121-128. Raleigh, North Carolina — May 29 - June 01, 2012. ISBN: 978-1-4503-1333-9 doi:[10.1145/2282338.2282364](https://doi.org/10.1145/2282338.2282364)

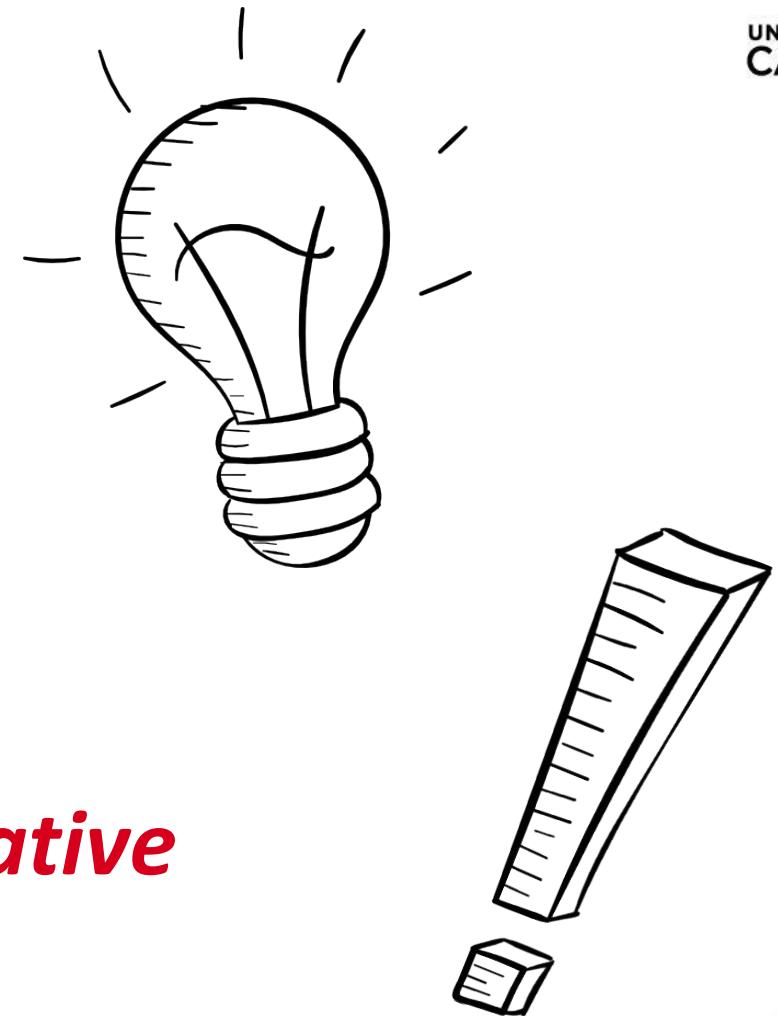
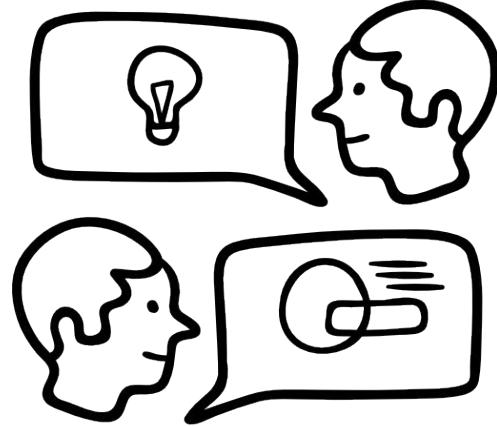
Salen, K. and Zimmerman, E. (2003). [Rules of Play: Game Design Fundamentals](#). MIT Press. (ISBN: 9780262240451)

Schell, Jesse. [The Art of Game Design, A Book of lenses](#). 2nd Edition, 2014, Carnegie Mellon University.

Smaldone, R. A., Thompson, C. M., Evans, M., Voit, W. Teaching science through video games. *Nature Chemistry*, 2017, Vol 9, 97-102. <https://doi.org/10.1038/nchem.2694>



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Experiment, Share, be Creative



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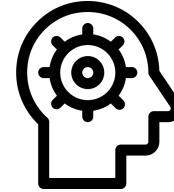




Activity 1

[PLAY Zoombinis](#)

Click on to see the assessment framework



[Back to presentation](#)



Rowe, E., Asbell-Clarke, J., Gasca, S., & Cunningham, K. (2017, August). [Assessing implicit computational thinking in Zoombinis gameplay](#). Poster presented at the International Conference on the Foundations of Digital Games in Hyannis, MA.

Valerie J. Shute, Chen Sun, Jodi Asbell-Clarke, Demystifying computational thinking, Educational Research Review, Volume 22, 2017, Pages 142-158, ISSN 1747-938X: <https://doi.org/10.1016/j.edurev.2017.09.003>