



**ALION**  
SCIENCE AND TECHNOLOGY



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# Why Games Work – The Science of Learning

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Booth 2535



## Tutorial Contents

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- 1 – Intro
- 2 – Science of Learning
- 3 – How Games Work
- 4 – Game Design
- 5 – Connecting the Dots
- 6 – Conclusion

# PART 1

## Introduction

“Greatness and nearsightedness are incompatible.” – Pink <sup>(6)</sup>



## The ‘Standard’ Goal

Learning Theory



Game Design



Awesome!



## Learning Objectives

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- You will learn to:
  - List the laws of learning
  - Explain why games work
  - Describe how games use the theory of Flow to impact learning
  - Explain the difference between intrinsic and extrinsic motivation
  - Describe the paradox of choice and how it impacts learning

## Why Games?

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- Entertainment Games *(16)*
  - 65% of US households play games
  - Average age of gamers: 37
  - 42% of gamers are women
  - Games is ~ \$24 Billion industry
  - Ex: Call of Duty - bigger open than Avatar or Titanic
- Learning Games *(17, 25, 26, 28)*
  - Can generate a 2 letter grade increase in economics
  - Can net a 50-80% increase in recruit performance
  - Can encourage kids with cancer to take medication
- Games can teach and change behavior!

## But Not Always ...

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- The Risk:
  - ‘Academizing’ the fun <sup>(18)</sup>
    - “It is possible to design a game that is the WORST of both worlds – a boring game that makes use of ineffective teaching methods.” - Clint Bowers <sup>(25)</sup>
- The Solution
  - Find the balance between:
    - Valid instruction
    - Engaging games
- We need to understand both
  - The science of learning
  - How games work

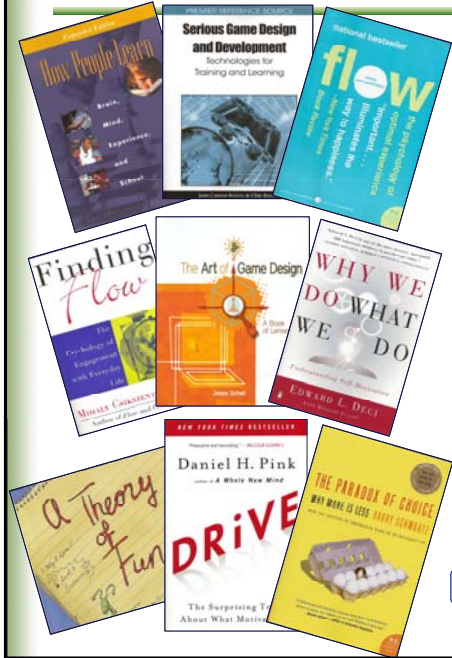
## Two Notes

8

- Games do NOT replace teaching
  - Just a tool
    - Like a book, video, or handout
- This talk is well researched
  - Lots of evidence
  - Complete paper on the topic<sup>30</sup>

# Resources and References

9



- US Army  
Fundamentals of Instruction
- US Navy  
Revolution In Training
- US Air Force  
Train the Trainers
- US FAA  
Aviation Instructor's Handbook
- Susan Coleman
- Clint Bowers
- Bruno Frey
- Jan Cannon-Bowers
- Robert Green
- John Lee
- Richard Ryan
- Richard Van Eck
- James Buchanan
- Talib Hussain
- Edwin Locke
- Richard Wainess
- Dustin Chertoff
- Michael Guerrero
- Kerry Moffit
- Ellen Menaker
- Alan Koenig
- Kelly Pounds
- Richard Blunt
- Mitchell Wade
- Curtiss Murphy

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## PART 2

# The Science of Learning

**“Teaching is a wonderful way to learn.”**  
**Carol Dweck (32)**



# What Improves Learning?

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## Laws of Learning <sup>1,2,3,31,30</sup>

**Readiness**

**Exercise**

**Effect**

**Intensity**

**Primacy** (\*\*)

**Recency** (\*\*)

\*\* Primacy & Recency are based on time  
Beyond the scope of this talk

# Narrow The Focus

12

## Laws of Learning for Games<sup>30</sup>

**Motivation** (from Readiness)

**Feedback** (from Exercise)

**Practice** (from Exercise)

**Positive Feelings** (aka Effect)

**Intensity**

**Choice/Involvement** (\*\*)

\*\* Choice/Involvement are  
from Effect, Readiness, Intensity

## Motivation and Feedback

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- **Motivation** (1, 2, 3, 4, 5, 6, 20, 22, 31)
  - Part of 'Readiness'
  - The holy grail
  - "Quite simply, motivated students learn more than unmotivated students"- US Navy
  - Increases involvement with learning, retention, and student performance
- **Feedback** (1, 2, 3, 4, 8, 23, 31)
  - Part of 'Exercise'
  - Critical to learning
  - Is how we perceive progress
    - Correlates actions to outcomes
  - An interesting story:
    - 'Without feedback, no learning can occur.'

## Practice and Effect

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- **Practice** (1, 2, 3, 4, 21, 31)
  - Part of Exercise
  - "A student learns by applying what he has been taught." – USAF
  - Time on task creates opportunities to learn
  - Repetition is 'necessary, but not sufficient'
- **Positive Feelings** (1, 2, 3, 4, 31)
  - Aka – 'Effect'
  - Learning is stronger with pleasant emotions
  - Keeps students engaged longer

## Intensity and Choice

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- Intensity (1, 2, 3, 4, 31)
  - Learning increases with vivid, sharp, intense activities – whether positive or negative
  - Practiced activities are more intense than passive lessons or texts
  - Real is most intense – aka learn on the job!
- Choice/Involvement (1, 2, 3, 25, 31)
  - Sub-parts of Effect, Readiness, and Intensity
  - Choice of challenge affects motivation
  - Coercion and external rewards are negatively associated with learning
  - Is complex - as we will see

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## PART 3

### Why Games Work

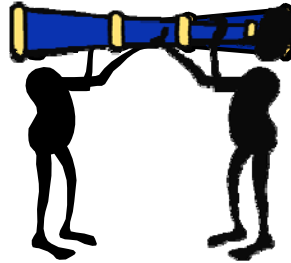
**“It is inconceivable that people are motivated solely or even mainly by external incentives” – Bruno Frey (19)**



## Change Perspective

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**Learning  
Design**



**Game  
Design**

- Let's flip this puppy around
- Now we can ask...

## The Big Question

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### “Why Do Games Work?”

- Is it art?
- Is it mystical?
- Maybe it's a secret?
  
- I propose an answer
  - A simple
    - Powerful realization



## The Answer

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- **Games work for the same reasons that learning works** <sup>(30)</sup>

**Motivation** (from Readiness)

**Feedback** (from Exercise)

**Practice** (from Exercise)

**Positive Feelings** (aka Effect)

**Intensity**

**Choice/Involvement** (\*\*\*)

## What?

20

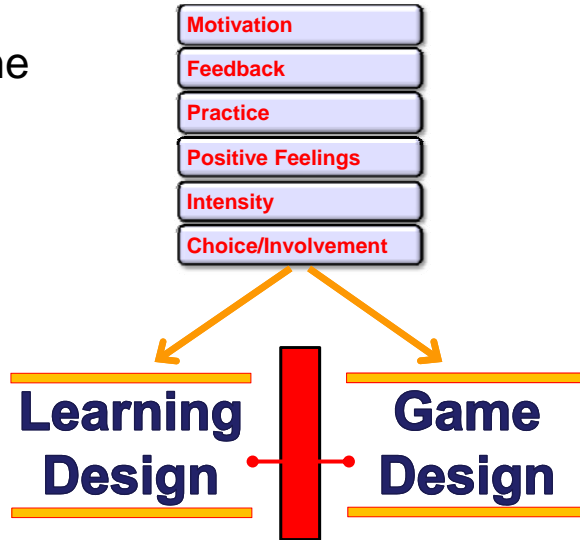
- Maybe wondering
  - ‘What does that even mean?’
- Maybe you’re asking
  - ‘Really?’
  - ‘Are we sure?’



## What's It Mean?

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- Let's assume
  - It's true
- If so, then



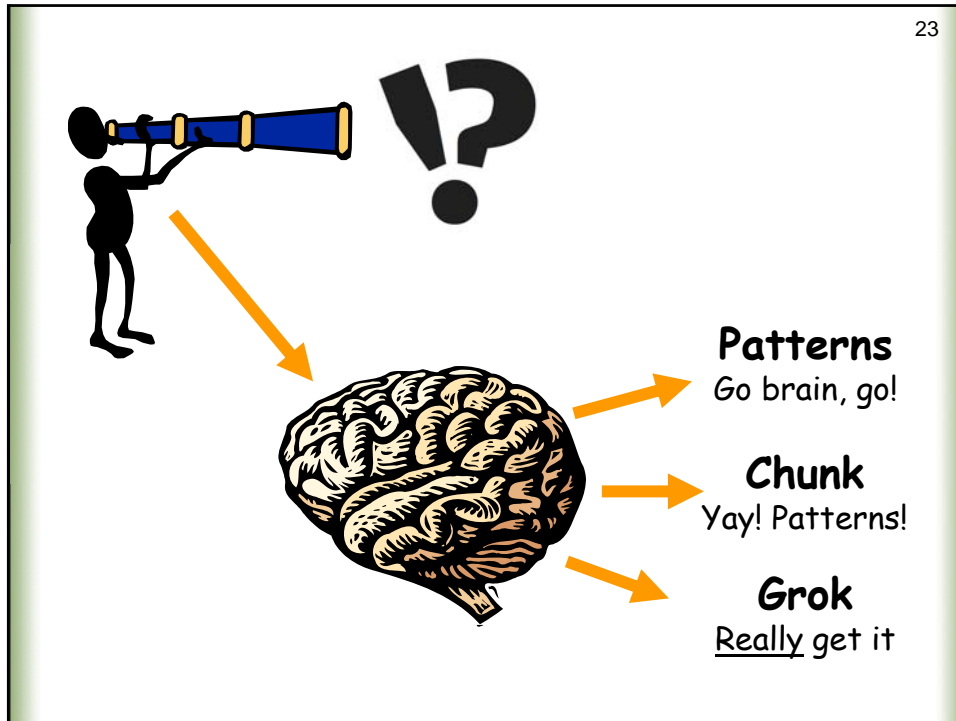
- That's powerful!

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... Interlude ...

**Raph Koster Minute**

A Theory of Fun  
For Game Design<sup>(12)</sup>



## Fun

- 1 - Another word for learning
- 2 - Act of mastering a problem

**"With Games,  
Learning is the Drug"**

## Good Game

"one that teaches everything it has to offer before the player stops playing"



## PART 4

# Game Design

**“Game Design is more art than science,  
more like cooking than chemistry.” –  
Jesse Schell <sup>(11)</sup>**



## Game Techniques <sup>(30)</sup>

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1. Flow
2. Feedback
3. Simplicity
4. Choice/Involvement
5. Immersion & Engagement
6. Practice
7. Fun

# 1 - Flow

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- (References: 5, 6, 7, 8, 9, 11, 15, 19, 20, 23, 26)
- What is Flow?
  - The optimal human experience
  - The 'state in which people are so involved in an activity that nothing else seems to matter' <sup>(8)</sup>
    - Mihaly Csikszentmihalyi
  - Complete focus - one with activity
  - Time becomes distorted
- Flow can occur in ANY activity
  - Reading, work, play, classrooms
- And – games
  - Flow is why we play games
  - The heart and essence of a game experience

# How to Create Flow?

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- There are four conditions for Flow:

## Clear Task

- Understand what must be done

## Feedback

- Clear feedback about progress
- Shows what succeeds and fails
- Usually immediate

## Attainable, Balanced Goal

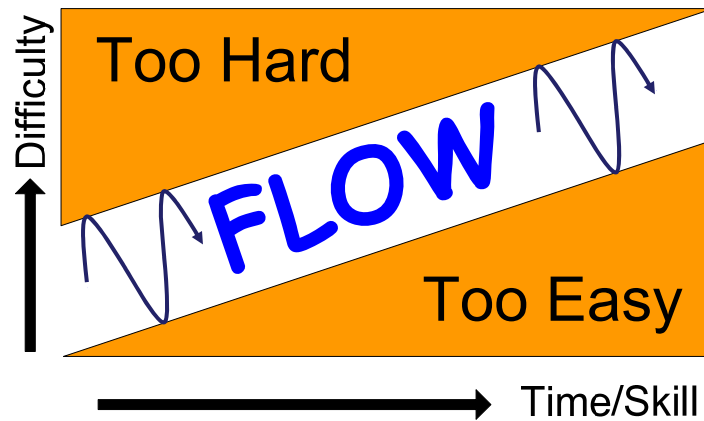
- Goal is challenging
- But within abilities
- And not overly long

## Concentration / Focus

- Lack of distractions
- Can fully attend to task

## What Flow Looks Like

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Flow creates a cycle of increasing learning

## Why Flow Matters

30

- Why do we care?
  - Flow is intrinsically motivating
  - Flow is a “magnet for learning” <sup>(9)</sup>
  - Flow is pleasurable
- Why else?
  - Flow involves feedback
  - Flow involves learner control
    - (aka choice)
  - Flow is linked to developing talents

## 2 - Feedback in Games

31

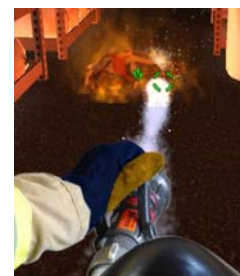
- Two Types <sup>(30)</sup>
- Type One - short term
  - Task completion
  - Progress
  - Immediate



- Natural consequences



Sims 3



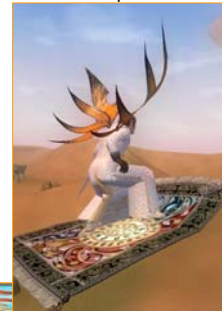
Damage Control Trainer

## Feedback in Games

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- Type two – holistic
  - Repetition - play again
  - Player development
  - Narrative progression
  - 'Meta' growth

Everquest 2



Damage Control Trainer



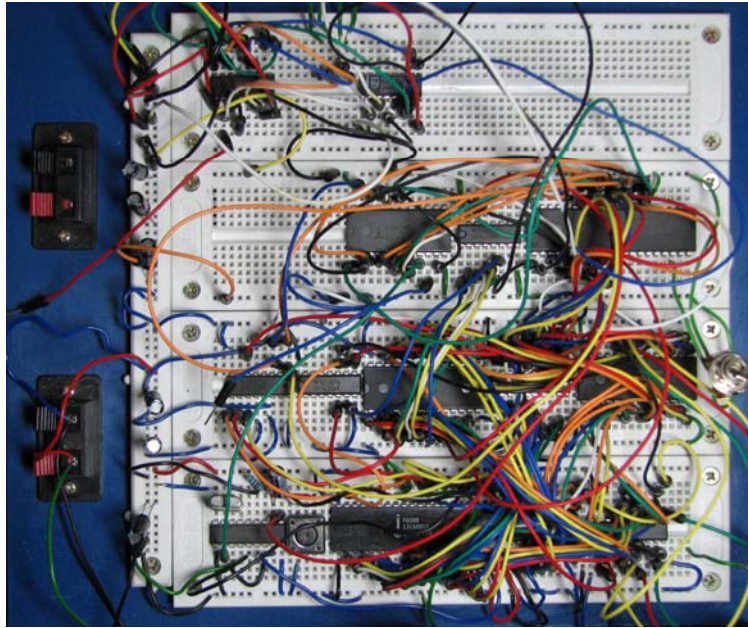
League of Legends



Royal Envoy

## 3 - Simplicity

33



## Simplicity

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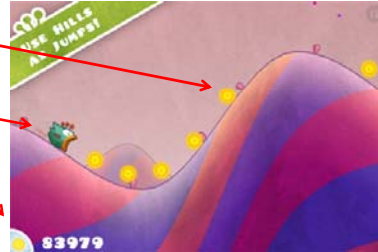
- Games simplify the world to
  - “goals and rules for action” – Csikszentmihalyi <sup>(8)</sup>
- Games offer ‘**transcendence**’:
  - “the player is more powerful in the game world than they are in the real world.” – Schell <sup>(11)</sup>
- Game design wisdom:
  - ‘Your garden is not complete until there’s nothing else you can remove.’ –
    - Will Wright <sup>(26)</sup>

## Simplicity (26,30)

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- Good Interfaces are Simple

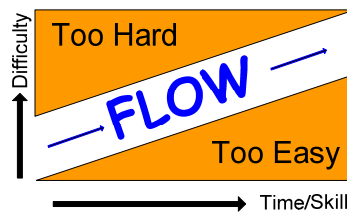
- Highlight goals
- Provide clear feedback
- Seem 'invisible'



Tiny Wings

- Promote Flow

- Avoid cognitive overload
- Balance difficulty
- Don't distract



- Simplicity impacts motivation

## 4 - Choice/Involvement (26,30)

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- Choice

- Game play IS choice & involvement
- Games are 'just a series of interesting and meaningful choices' – Sid Meier
- Control via choice is a part of Flow
  - Which affects motivation

- But wait! Not so fast!

- There are some big 'Buts!' with choice

## Paradox of Choice

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- Barry Schwartz (7)
  - Some choice is good
    - But too much choice is bad!



- “As the number of choices grows further, the negatives escalate until we become overloaded. At this point, choice no longer liberates, but debilitates.” (7)

## Paradox of Choice (26,30)

38

- Three problems:
  - Increases difficulty (A LOT)
    - Option paralysis
    - Postpone decisions
    - Increases cognitive load
  - Leads to ‘worse’ decisions (less accurate)
    - People are not good at comparing many things
    - We simplify the criteria (can become random)
    - Hard to correlate decisions to outcomes (feedback)
  - Adds regret & sense of ‘loss’ – distracts us
- Impedes flow & decreases motivation
- Games generally
  - Limit # of choices
  - Spread decisions out over time

## Cost of Choices

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- Opportunity Cost (Buchanan) <sup>(10)</sup>
  - The cost of an option includes
    - The value of the option itself
    - PLUS the cost of missed opportunities
  - Ex: Cost of attending this session is
    - The value of this topic
    - PLUS you missed other talks!
- Thank you for attending!
- The Impact <sup>(10, 7, 30)</sup>
  - Increases difficulty
  - Adds distractions
  - Breaks flow
  - Compounds with paradox of choice



## 5-Immersion and Engagement <sup>(24)</sup><sup>40</sup>

- Immersion ← Passive
  - Becoming engrossed in a story or a concept
  - Creates Presence - a sense of 'being there'
  - Generates **positive feelings** of interest
  - Passive consumption of material/media
- Engagement ← Active
  - Trying to understand the meaning of or application of an idea
  - Working to solve a puzzle or problem
  - Actively engaged in thinking
    - Increases **motivation**

# Games Use Both!

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- Games = Immersion + Engagement
  - Creates **intensity!**
  - **Vivid** experiences

## Immersion



Red Dead Redemption

## Engagement



7 Little Words

# 6 - Practice

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- This is obvious...
  - I hope <sup>(26,30)</sup>
- Games use practice to promote mastery
- Games encourage replay
- Games use failure
  - With games, “failure is a part of the process that leads to success” – Beck <sup>(13)</sup>
- Caution - can break flow! <sup>(27)</sup>
  - Instant death
  - Long recoveries
  - Overly hard
  - Excessive practice – boredom



## Repetition... Again...

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- Repetition
  - Games are great at encouraging replay <sup>(27)</sup>
- Example
  - Closing doors. Over...
    - And over
      - And over ...
      - Until ...
  - Transference!
- More cautions:
  - Repetition without learning <sup>(26)</sup>
    - Ex: What's on a Penny?
  - Necessary <sup>(4)</sup>
    - But not sufficient



## 7 - Fun

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- 'Fun' is hard to define
    - But it matters to game designers
  - Includes <sup>(26,30)</sup>
    - Immersion
    - Engagement
    - Pleasure
    - Satisfaction
    - Fiero (triumph)
    - The joy of doing
- Positive Feelings
- Fun is "Another word for learning" <sup>(12)</sup>

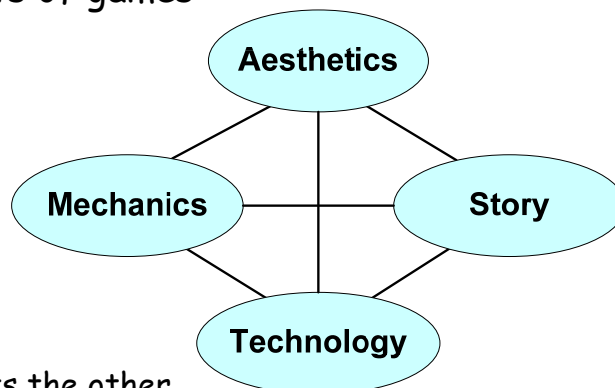
... Interlude ...

## Jesse Schell Minute

Art of Game Design,  
A Book of Lenses <sup>(11)</sup>

## Elemental Tetrad

Basic elements of games



- \* Each affects the other
- \* All are important

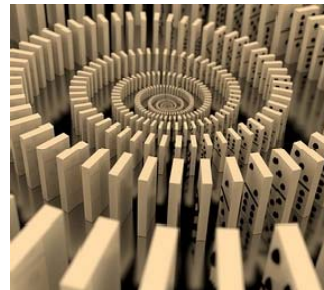
## Simplicity

Games are simpler than real life



## Rule of the Loop

The more times you test and improve your design, the better your game will be.



## Players want to be judged

But dislike being judged unfairly.  
Games judge simply and objectively.

# PART 5

## Connecting the Dots

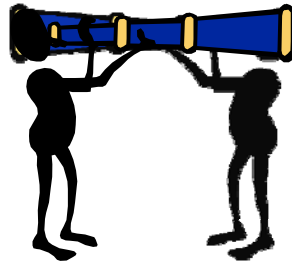
### Moderation in All Things



## Perspective... Again...

49

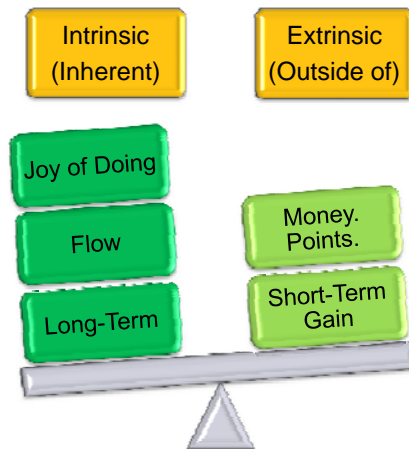
**Learning  
Design**



**Game  
Design**

## Revisit Motivation (4, 5, 6, 15, 19, 20) 50

- 2 types
  - Intrinsic
  - Extrinsic



- **Intrinsic > Extrinsic**
  - Increases creativity
  - Increases long-term interest (linked to learning)
  - Increases motivation

## Which is Which?

51

- It's not so simple...
  - Maybe we enjoy earning external rewards
    - And so strive for them - intrinsic
    - Operant conditioning can be motivating
  - Are the points feedback?
    - Help show progress - affects intrinsic
  - Is there a social aspect?
    - Competition can be intrinsic
- Which is which?
  - We need a rule of thumb...

## The Issue is Control

52

- Beware control (5, 6, 15)
  - Rewards that attempt to control behavior have negative consequences
    - Danger - people perceive this intuitively
  - Acknowledgement (w/o control) is okay
  - Humans need autonomy (some is enough)
- This REALLY matters
  - “Try to encourage a kid to learn math by paying her for each work-book page she completes – and she'll almost certainly become more diligent in the short term and lose interest in math in the long term.” – Pink (6)

## Gameplay vs. Instruction

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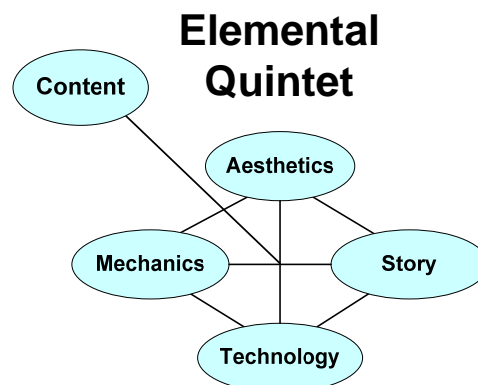
- Option 1 – trump gameplay
  - Does it cease to be a game?
  - Do you lose the benefits?
- Option 2 – trump instruction
  - Then what are you teaching?
  - Does the project lose meaning?



## Integrating the Two

54

- Let's revisit Schell's Diagram (11, 27)
- Add Content
  - Whatever you want the learner to walk away knowing
- 5 = Quintet
- Find balance
  - All elements are important
  - Each affects the other - even content



## PART 6

# Conclusion

**“Rewards ... turned play into work,  
and the player into a pawn”**

– Edward Deci <sup>(5)</sup>



## The Sawyer Effect

- From Mark Twain's
  - Tom Sawyer



– “Practices that can either turn play into work  
or turn work into play” – Pink, Deci <sup>(5, 6)</sup>

## Putting It All Together

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Laws of Learning	Game Techniques
Motivation	Flow. Intrinsic Motivation. Games are fun. Moment to moment decisions.
Feedback	Feedback is essential to Games. Part of flow. Simplicity correlates actions to outcomes. Near-term/holistic.
Practice	Practice to promote mastery. Failure. Increasing difficulty. Repetition.

## Putting It All Together (cont)

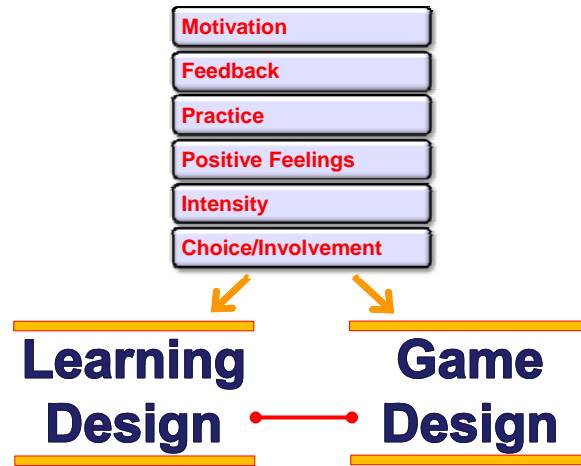
58

Laws of Learning	Game Techniques
Positive Feelings	Fun. Flow is pleasurable. Simplicity and involvement encourages accomplishment and mastery.
Intensity	Flow is intense focus. Immersion and engagement → intensity. Feedback loop is intense actions/outcomes.
Choice/ Involvement	Games simplify the world to meaningful decisions. Learning via moment to moment actions.

# The Question and the Answer

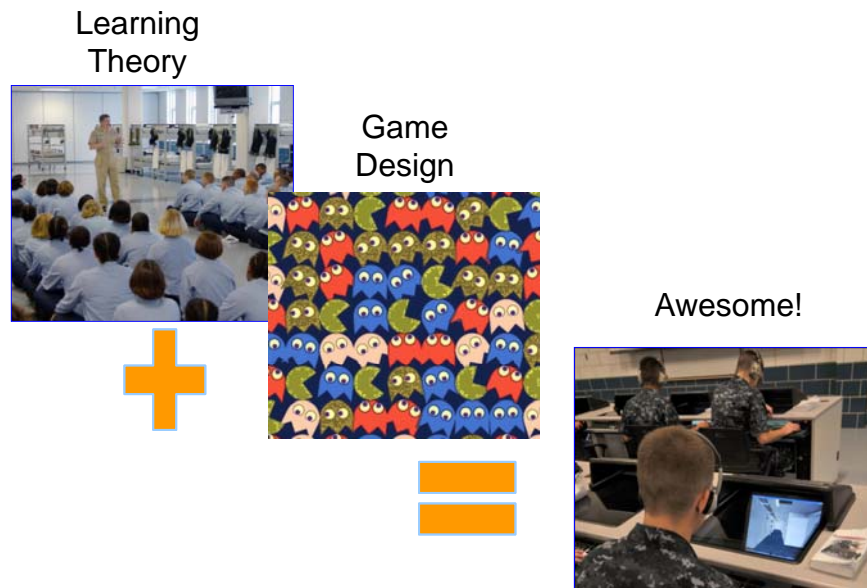
59

- Q: “Why Do Games Work?”
  - A: For the same reasons as learning!



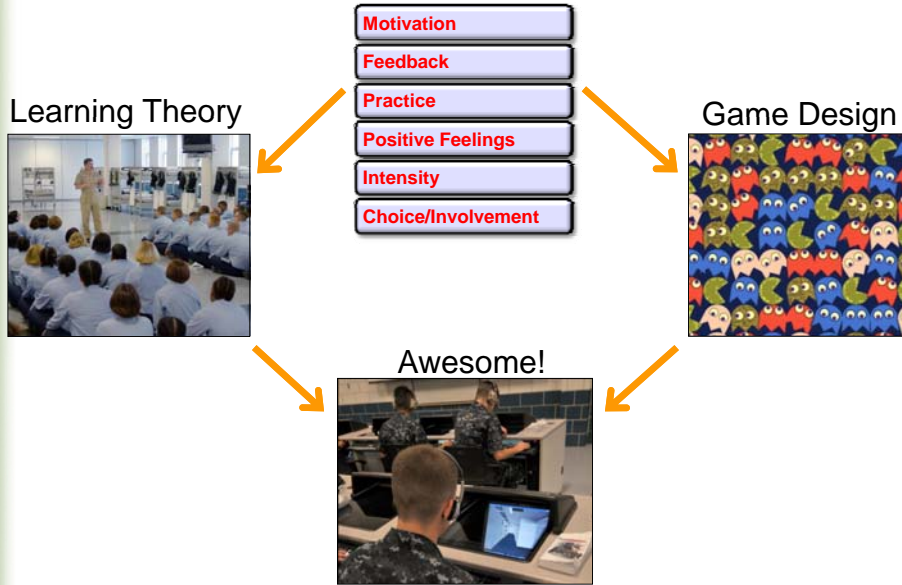
# Our ‘Starting’ Goal

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# A Change in Perspective!

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**THE END**

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## Why Games Work – The Science of Learning

I/ITSEC 2011

Thank you for attending!  
Curtiss Murphy

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- 29) "*Damage Control Trainer – A Serious Games Case Study*", Murphy, Hussain, 2009.
- 30) "Why Games Work and the Science of Learning", Murphy, 2011

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- Games and photos are copyright of their respective owners
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- Game Acknowledgements
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  - Sims 3 (Electronic Arts)
  - Everquest 2 (Sony)
  - Royal Envoy (Playrix)
  - League of Legends (Riot)
  - Tiny Wings (Andreas Illiger)
  - Red Dead Redemption (Rockstar Games)
  - 7 Little Words (Blue Ox Technologies)
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  - Forest Fairy (Deeble)
  - Thinking (gavinzac)
  - Guitar Hero 1 (Severin Sadjina)
  - Interobang (Stewf)
  - Too many choices (cwgoodroe)
  - #19-Too many choices (elviskenedy)
  - Designed for men, by women (Kaptain Kobold)
  - Colorful door (Brentdanly)
  - Domino Spiral (fracturedpixel)
  - Bird Amazement (skywidedesign)
  - Green Pac-Man (Patrick Hoesly)
  - Electric me with more lasers (navfy)
  - Red Dead Redemption (Gamer Gourmet)
  - Magic of the holidays (jmtimages)
  - Teaching the adult learning cycle (pmorgan)
  - I will meet you in the garden gate (bitzcelt)