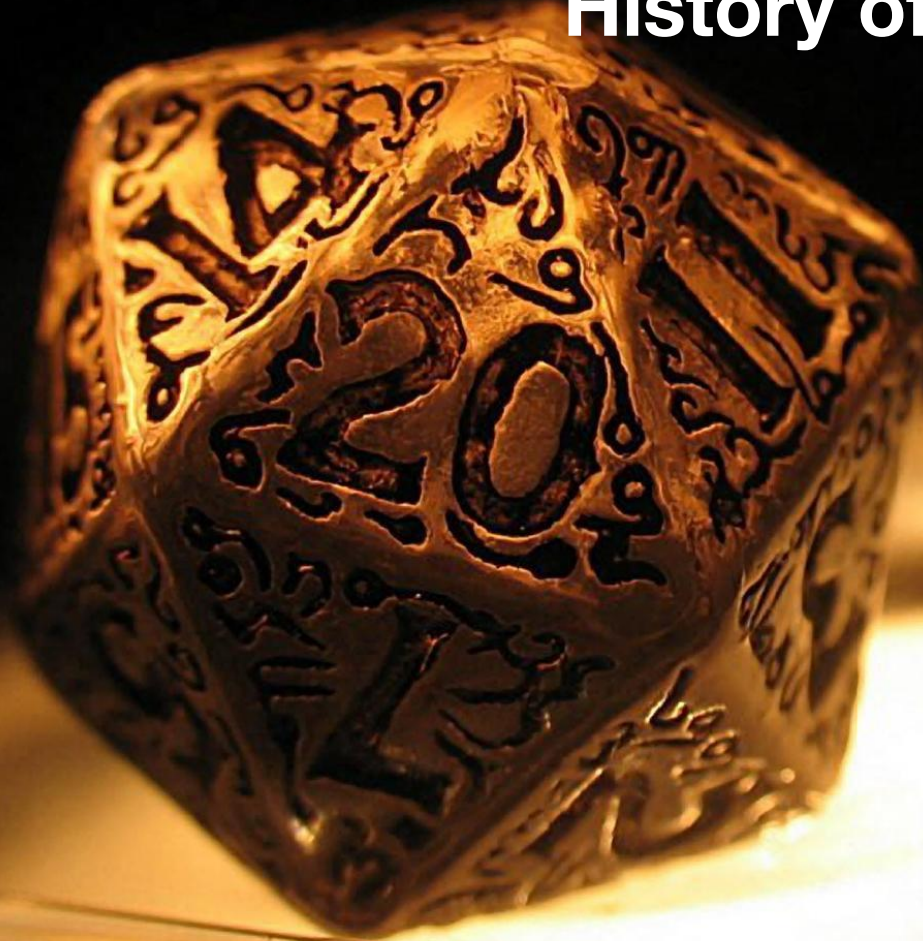


Gamification in Online Learning: History of Science for Engineers

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University of Oklahoma



Gamification



**3D GAME
LAB**

Why this format?

Gamification “attempts to harness the motivational power of games and apply it to real-world problems.”

(Lee and Hammer, 2011: 1)



Toward a Science of Learning Games

Paul Howard-Jones¹

ABSTRACT—Reinforcement learning involves a tight coupling of reward-associated behavior and a type of learning that is very different from that promoted by education. However, the emerging understanding of its underlying processes may help derive principles for effective learning games that have, until now, been elusive. This article first reviews findings from cognitive neuroscience and psychology to provide insight into the motivating role of uncertain reward in games, including educational games. Then, a short experiment is reported to illustrate the potential of reward-based neurocomputational models of behavior in the understanding and development of effective learning games. In this study, a reward-based model of behavior is shown to predict recall of newly learned information during a simple learning game.

established understanding may help explain the difficulties encountered by those attempting to combine learning and gaming, which have led some commentators to write the “only consensus in this whirlwind of activity seems to be that educational games are something of a failure” (Zimmerman & Fortugno, 2005). If we wish to imbue learning with the excitement experienced by computer game players, then we need to understand more about the processes linking cognition, emotion, and motivation. As pointed out elsewhere in this journal, neuroscience encourages us to consider these concepts as closely intertwined (Fisher, Marshall, & Nanayakkara, 2009; Immordino-Yang & Damasio, 2007) and potentially offers new ways of theorizing the motivated learner.

THE ELUSIVE THEORY OF “EDUTAINMENT”

Games (Bergin, 1999; Gee, 2003) are a potential source of inspiration for teachers wishing to engage their learners, and there have been many attempts to develop experiences that combine education with the entertainment of games to generate so-called “edutainment.” Yet, attempts to find the critical ingredients for such engagement have produced a bewildering array of candidates. Malone (1981) identified components of fantasy, challenge, and curiosity. Johnson (2005) drew attention to how most computer games now require no initial knowledge or manual. Garris, Ahlers, and Driskell (2002) emphasized the importance of feedback responses, reflection, and active involvement. The reason given by most gamers for pursuing their passion is fun yet some academics dismiss this as a “red herring” for educators because, they claim, children find learning fun enough already (Kirriemuir & McFarlane, 2004). The same authors suggest simplicity and repetition are the reasons why educational games often fail. And yet, it can be observed that many children find simple and repetitive games such as Tetris more absorbing than a well-planned lesson. A lack of

THE COGNITIVE NEUROSCIENCE OF MOTIVATION

When reviewing the cognitive neuroscience of reward and motivation, note that there are differences in how terms are applied in neuroscience compared with common usage. For example, in cognitive neuroscience, reward usually refers to short-term incentives that reinforce behavior. The relationship between motivation and learning in neuroscience has been studied chiefly in the context of reinforcement learning (Wise, 2004), a type of learning thought to support foraging among natural food sources (Daw, O’Doherty, Dayan, Seymour, & Dolan, 2006) and an ability we share with many other animals. Here, approach motivation is considered as the incentive to approach or the extent to which we want something. This appears closely related to the uptake of dopamine in a midbrain region called the ventral striatum and, in particular, a small nucleus of densely populated neurons within this region called the nucleus accumbens. Midbrain dopaminergic activity has been shown to increase when we are exposed to a variety of pleasures including food (Farooqi et al., 2007), money (Knutson, Adams, Fong, & Hommer, 2001), and computer games (Koeppe et al., 1988). This visceral type of motivation may have less to do with the higher-order thinking processes that appear to motivate us toward other activities that are less gratifying in the short term, such as pursuing a difficult course of professional development. Nevertheless, as has been pointed out by Van Geert and Steenbeek (2008), short-term motivational processes may have a powerful influence on long-term outcomes.

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Midbrain dopaminergic activity has been shown to increase when we are exposed to a variety of pleasures including food, money, and computer games.

Dopamine orients attention and enhances the making of connections between neurons, which is the brains' basis for learning.

Paul Howard-Jones, "Toward a Science of Learning Games"

Maximum signal [dopamine release] corresponded to the maximum available reward in that context.

[An] anticipatory ramp of dopamine, together with the previous spike, resulted in uncertain reward generating more dopamine overall than either 100% certain or wholly unexpected reward. In other words, uncertain reward appears to increase the type of dopaminergic response that has been linked to motivation.

Paul Howard-Jones, "Toward a Science of Learning Games"

Traditional Face-to-Face

Four themes, each time running through the whole chronology:

Cosmos

Planet

Body

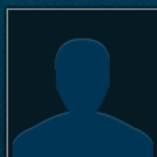
Technology

Topic Map

	Astrosciences	Earth Sciences	Biological Sciences	Medicine/The Body	Social Sciences
Chron/topic	A00: Campaign Overview	E00: Campaign Overview	B00: Campaign Overview	M00: Campaign Overview	S00: Campaign Overview
Ancient	ANE Cosmology	Ancient Earth	Domestication of Animals	Asclepius	Religion
The Greeks and Romans	Plato, Aristotle, Ptolemy	4 Elements/Qualities	Aristotle's Zoo	The Greek Body	What is Natural Philosophy?
Non-Western Groups	Islamic Astronomy	Meso-American Natural Philosophy	Life in Meso-America	East vs. West	Non-Western Ways of Thought
Islamic Period	Ptolemy in Arabic	Islamic Alchemy	Botany and Agriculture	Hospitals	The Quran and 'ilm
Medieval Europe	Copernicus	Medieval Physics	Herbals and Bestiaries	Medical Training in Medieval Europe	Universities
Scientific Revolution	3 Men and a Theory	Mechanics	Exploration and New World Biology	Andreas Vesalius	Psychology
Early Modern Europe	Reactions to the New Cosmos	Alchemy and Chemistry	How do we pass life along?	Circulation of the Blood	Theories of Personality
18th/19th centuries	Seeing the Heavens	Geology (Rocks and Religion)	Evolution of Evolution	Medical Treatment of Women	Anthropology
20th/21st Centuries	Einstein and Uncertainty	The Manhattan Project	DNA and Life	Disease and Antibiotics	Archaeology

Chronological Map

Code:	Chron/topic	Social Sciences	Astrosciences	Earth Sciences	Biological Sciences	Medicine/The Body	Social Sciences
010	Ancient	Religion	ANE Cosmology	Ancient Earth	Domestication of Animals	Asclepius	
020	The Greeks and Romans	What is Natural Philosophy	Plato, Aristotle, Ptolemy	4 Elements/Qualities	Aristotle's Zoo	The Greek Body	
030	Non-Western Groups		Islamic Astronomy	Meso-American Natural Philosophy	Life in Meso-America	East vs. West	Non-Western Ways of Thought
040	Islamic Period	The Quran and 'ilm	Ptolemy in Arabic	Islamic Alchemy	Botany and Agriculture	Hospitals	
050	Medieval Europe	Universities	Copernicus	Medieval Physics	Herbals and Bestiaries	Medical Training in Medieval Europe	
060	Scientific Revolution		3 Men and a Theory	Mechanics	Exploration and New World Biology	Andreas Vesalius	Psychology
070	Early Modern Europe		Reactions to the New Cosmos	Alchemy and Chemistry	How do we pass life along?	Circulation of the Blood	Theories of Personality
080	18th/19th centuries		Seeing the Heavens	Geology (Rocks and Religion)	Evolution of Evolution	Medical Treatment of Women	Anthropology
090	20th/21st Centuries		Einstein and Uncertainty	The Manhattan Project	DNA and Life	Disease and Antibiotics	Archaeology



Group



645 | 5000

Rank



145 | 500

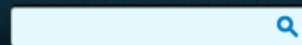
MST Hist 2530 V2



Available 3

In Progress 0

Completed 66



Name

XP

Avg Time

Rating

Category

Due Date

**M31: History of the Body--East vs. West**

10

-- mins

No Rating

Medicine

Mar 14, 2015



QUESTS

0



REWARDS

6



GROUP



ANNOUNCEMENTS

5

**M32: Mo, Qi, and Treatment of the Body in China**

5

-- mins

No Rating

Medicine

Mar 14, 2015

**M33: Alternative Treatments?**

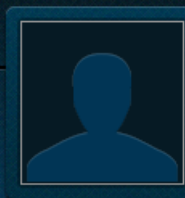
10

-- mins

No Rating

Medicine

Mar 14, 2015



Group



655 | 5000

Rank



155 | 500

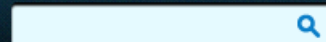
MST Hist 2530 V2



Available 0

In Progress 3

Completed 66



Name

XP

Avg Time

Rating

Category

Due Date

**M31: History of the Body--East vs. West**

10

-- mins

No Rating

Medicine

Mar 14, 2015

Comparing and contrasting views of the Eastern and Western Bodies

In Progress



Prerequisites

- Required XP: 35
- Quest: E83: Geology: Rocks versus Religion? (part 2)

Tags: [Body](#) | [Ancient Greece](#) | [Ancient China](#) | [Medicine](#)

Available as of: March 8, 2015

**M32: Mo Qi and**

5

mins

No Rating

Medicine

Mar 14, 2015

QUESTS

3

REWARDS

6

GROUP

ANNOUNCEMENTS

5



GamerTag321

Explorer 1st Class

XP 3,325

Group

1,745 | 3,000

Rank

280 | 300

Cobra Kai



QUESTS 2

REWARDS 1

GROUPS

Game Builder

Group Manager

Quest Builder

Award Builder

Quest Approver

[faq](#) | [help](#) | [support](#)

Rewards

Badges



Badge One



Another Badge



Fire Warlock



Master Spy



Tomahawk Champ



Unlock This



Unlock This



Unlock This



Unlock This



Unlock This

Achievements



Badge One



Another Badge



Fire Warlock



Master Spy



Tomahawk Champ



Group										0 5000
Rank										0 50

MST Hist 2530

Available 383

In Progress 0

Completed 0



QUESTS 0

REWARDS 0

GROUP

ANNOUNCEMENTS 7

GROUP MANAGER

QUEST BUILDER

REWARD BUILDER

QUEST APPROVER (15)

Name	XP	Avg Time	Rating	Category	Due Date
010: Ancient Campaign Overview	5	2 mins	★★★★★	Ancient	No end date
020: Greeks and Romans Campaign Overview	5	3 mins	★★★★★	Greeks and Romans	No end date
030: Non-Western Groups Campaign Overview	5	2 mins	★★★★★	Non-Western	No end date
040: Islamic Period Campaign Overview	5	3 mins	★★★★★	Islamic	No end date
050: Medieval Europe Campaign Overview	5	3 mins	★★★★★	Medieval	No end date
060: Scientific Revolution Campaign Overview	5	10 mins	★★★★★	Scientific Revolution	No end date
070: Early Modern Europe Campaign Overview	5	2 mins	★★★★★	Early Modern	No end date



Group										0 5000
Rank										0 50

MST Hist 2530



Rewards



QUESTS 0

REWARDS 0

GROUP

ANNOUNCEMENTS 7

GROUP MANAGER

QUEST BUILDER

REWARD BUILDER

QUEST APPROVER (15)

Badges

Maximus Decimus ...	Joe Miner	Genie	Dr. Ian Malcolm	Dr. Quinn, Medic...
Dr. Jones' Hat	Philosopher Han ...	Gerard of Cremona	Margaret Cavendi...	Fellow of the Ac...
Achievements				
Hyperactive	Five Ball	Ten Ball	10 Pins	Half-Century
Centurion	Skill Wraith	Jar Jar Binks	Star Trek Red Shirt	Tribble

Collaborative Technology

- 3dgame-lab.org
- Hackpad
- VoiceThread
- Google Drive - file sharing
- YouTube

Strengths of the Design

- Modular design
- Gamification - XP, rewards, leaderboard
- Badges
- Student choice of path
- Challenges traditional grading

Student Feedback

Quest Name	XP	Avg. Time	Rating	Category	Active	Completed
010: Ancient Campaign Overview	5	2	4.31	Ancient	1	29
020: Greeks and Romans Campaign Overview	5	3	4.13	Greeks and Romans	1	30
030: Non-Western Groups Campaign Overview	5	2	4.38	Non-Western	0	27
040: Islamic Period Campaign Overview	5	3	4.44	Islamic	1	25
050: Medieval Europe Campaign Overview	5	3	4.44	Medieval	1	25
060: Scientific Revolution Campaign Overview	5	10	4.29	Scientific Revolution	1	25
070: Early Modern Europe Campaign Overview	5	2	4.69	Early Modern	1	26
080: 18th and 19th century Campaign Overview	5	3	4.44	18th and 19th Century	2	24
090: 20th and 21st century Campaign Overview	5	3	4.53	20th and 21st Century	0	25
A00: Astrosciences Campaign Overview	5	3	4.6	Astro-Sciences	1	30
A11: Cosmology in Ancient Egypt	20	5	4.86	Astro-Sciences	1	30
A12: Cosmology in Mesopotamia	25	18	4.17	Astro-Sciences	1	30
A13: Mesopotamian Mathematics	40	17	3.88	Astro-Sciences	1	30
A21: Celestial Motions	25	22	3.88	Astro-Sciences	1	27
A22: Anaximander Discussion	25	25	4.06	Astro-Sciences	3	24
A23: Plato's Forms and Philosophy	25	23	4.3	Astro-Sciences	3	23
A24: Ptolemy's Ptool Kit	25	14	4.53	Astro-Sciences	2	26
A31: Islamic Science	25	66	3.67	Astro-Sciences	5	14
A32: Astrosciences in the Islamic World	60	26	4.39	Astro-Sciences	1	26
A33: Tusi Couple	25	15	3.93	Astro-Sciences	2	26
A41: John of Hollywood, Sacrobosco	25	20	4.39	Astro-Sciences	0	26
A51: Copernicus	100	42	4.41	Astro-Sciences	0	26
A52: Tycho's Moose	25	35	3.56	Astro-Sciences	3	17
A53: Kepler & Theology	40	60	3.35	Astro-Sciences	1	23
A61: Galileo's Sidereus Nuncius and Patronage	40	17	4.67	Astro-Sciences	0	22

Limitations of the Design

Just another LMS

- The silo effect as opposed to open web
- students will lose access at some point

Responses

- We agree
- The badges are exportable

Limitations of the Design

Coding problems

- Self-replication glitch
- Teacher side GUI is limited
- Gradebook integration
- Platform may be undersupported

Outcomes--Face to Face

- Of 1000 students over 10 semesters
 - Grade average: 85%
 - Standard distribution
- Drop rates: 10%
 - standard rates for humanities at both institutions
- Students are comfortable with the traditional face-to-face format

Outcomes--Online

- Of 29 students
 - 8 had no online course experience
 - 16 had at least one online course
 - 4 had blended course experience
- Drop rates: 4 of 31 total
 - 12.9 %
- Grades: 23 As; 1 B; 2Ds; 1F
 - Average: 91%
- Online format is self-paced
 - but the students recognize their own procrastination

Outcomes--Blended

- Of 29 students
 - 7 had no online course experience
 - 17 had at least one online course
 - 5 had blended course experience
- Drop rates: 3 of 29
 - 10.3%
- Grades: 10As; 12Bs; 1C; 1D
 - Average: 89%
- Blended
 - They like that they get the face-to-face contact
 - Like that the online portion has deadlines

Conclusions

Learning objectives for this class (in any format) are:

- Improve writing skills
- Engage with primary and secondary sources
- Reconsider preconceptions about science

Skills Tracking

Name/I.	ISTE NETs Teachers ISTE 2: Design and Develop Digital-Age Experiences and Assessments	ISTE NETs Teachers ISTE 4: Promote and Model Digital Citizenship and Responsibility	Iowa Core (History) MS.H.1 Historical patterns, periods of time & relationships between elements.	Iowa Core (History) MS.H.2 How/why people create/maintain/clear power/authority/governance	Iowa Core (History) MS.H.4 Individuals/group in society as promoters of change status	Iowa Core (History) MS.H.8 Cause/effect relationship, historical thinking to interpret events/issues
rs	30	15	280	20	100	
c	30	10	280	20	100	
land	30	20	280	20	100	
ary	30	5	165	20	50	
ess						
c	30	15	165	20	50	
ent						
is	30	10	140		50	
er	30	10	255	10		
r	30	10	255	20	100	
ard	30	5	140	10	50	75
ver	30	10	230	10	50	
ner	30	10	165	20	25	
ez	30	10	280	20	100	
VAGEL	30	10	205	10	150	75
jes	30	5	255	20	100	
meyer	30	15	230		75	
t	25	5	140	10	150	
son	30	15				
s	30	10				

Learning Management Systems

