A Cognitive Framework for Game Based Learning

What we now know about learning from Neuroscience and Psychology

White Paper

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EXECUTIVE SUMMARY

There are two disciplines which underpin all learning – neuroscience and psychology.

In this white paper, I look at the role of neuroscience in supporting learning. I then survey current research about what makes learning effective both neurologically and psychologically.

Building on this solid foundation I then propose a simple "Cognitive Framework for Game-Based Learning."

The framework consists of 12 key principles which can be used as a checklist to design effective team learning interventions.

1. THE KEY ROLE OF NEUROTRANSMITTERS IN LEARNING

According to Andy Brunning [1], although there are over 100 neuro-transmitters, 8 of which drive cognitive functions such as learning, memory and motivation.

"Communication between neurons in the brain is accomplished by the movement of neuro-transmitting chemicals across the gap (synapse) between them. These chemicals are released from the 'terminal' of one neuron, and accepted by the receptor on the next neuron".

There are two main types of neurotransmitter: excitatory neurotransmitters which cause neurons to fire and inhibitory neurotransmitters when prevent neurons firing.

Pete Jenkins explores how "gamification" can stimulate 4 specific neuro-transmitters [2] which in turn promote beneficial cognitive activities – Dopamine, Serotonin, Endorphins and Oxytocin:

Dopamine

Dopamine is associated with feelings of pleasure, satisfaction and addiction, movement and motivation. The feelings of satisfaction caused by dopamine can become desired, and to satisfy this the person will repeat behaviours that lead to release of dopamine. Games which offer novelty and feedback can stimulate Dopamine.

Serotonin

Serotonin contributes to feelings of well-being and happiness. Low levels of serotonin have been linked to depression, anxiety, and some mental disorders. Exercise and light levels can both have positive effects on the levels of serotonin. Games which offer recognition and praise can stimulate Serotonin.

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Endorphins

Endorphins are a range of compounds, the biologically active section of which is shown above, formed from long chains of multiple amino acids. They are released in the brain during exercise, excitement, pain, and sexual activity, and produce a feeling of well-being or even euphoria. Games which offer the achievement of difficult challenges can stimulate Endorphins.

Oxytocin

Oxytocin is believed to be key to how we bond with others and creates strong feelings of contentment and has been shown to create trust in groups and altruism in individuals. Games which promote collaboration can stimulate Oxytocin.

2. THE GOLDILOCKS EFFECT: OPTIMUM LEVELS OF STRESS FOR LEARNING

Daniela Kaufer [3] discusses the important question of the level of stimulation required to optimise learning and suggests that "Moderate stress is beneficial for learning, whilst mild and extreme stress are detrimental ….. Stress and performance are related in an "inverted U curve". Stimulation to learn requires a moderate amount of stress (measured in the level of cortisol)".

Cortisol is one of the 3 stress neurotransmitters (along with Adrenaline and Norepinephrine) – how the 3 interact is described in more detail here [4]. Kaufer also interestingly observes that what feels like moderate stress to one person can often feel like low stress or high stress to another individual [3]

3. ACTIVE LEARNING STIMULATES DIFFERENT PARTS OF THE BRAIN

Kaufer also discusses the importance of what she calls "Active learning" where many different areas of the brain are stimulated at the same time. Thus "blending" learning activities which stimulate the lower-level parts of the brain for understanding and remembering along with exercises which promote the higher-levels such creativity, evaluation, analysis, decision-making, association, and motivation can be highly effective for learning.

4. STRUCTURED REPETITION IS IMPORTANT FOR LEARNING

In an article in the Guardian [5] Ben Martynoga, a neuroscientist and science writer, discusses the neurological benefits of "Spaced Learning". Spaced learning is a teaching approach where content is intensively taught multiple times with breaks in between.

Neuroscientists have discovered, originally through non-human experimentation, that repeated stimuli, with precisely timed gaps, are one of the most reliable ways to convince neurons that an event is memory-worthy.

Ben also reinforces Pete Jenkin's assertion that meaningful rather than trivial challenges produce the best results in learning by suggesting "learning results in physical changes to the brain, but dramatic change requires meaningful tasks and considerable effort".

5. A COGNITIVE FRAMEWORK FOR GAME BASED LEARNING

I conclude this paper by attempting to extract the main research points into a cognitive framework for effective GBL based around 12 key principles which you can use as a design checklist in terms of whether your GBL is hitting the right learning buttons both neurologically and psychologically.

1. CONTEXTUAL RELEVANCE

Activities which are relevant to the learner's own environment are the most effective for learning. Credibility and context are more important than hyper-realism [7].

2. NOVEL EXPERIENCES

Unusual, fun, experiential and memorable situations stimulate the release of dopamine in our brains which is associated with feelings of pleasure, satisfaction and motivation [2].

3. SERIOUS FUN

Learning is best when learners perceive consequences from the learning activity, so they avoid the mindset – "it's just a game". Involvement of senior business sponsors is an example tactic [9].

4. MODERATE STRESS

There is an optimum level of stress (cortisol) for learning - not too high or low. Example stress factors include changing the environment and the time allowed in rounds [3,7].

5. SPACED LEARNING

Repetition and reinforcement strongly promote retention and retrieval. Multiple short sessions, where the same topics are revisited, are more effective than long sessions [5].

6. BLENDED LEARNING

Learning spanning lower (e.g. remembering) and higher (e.g. analysis) centres of the brain is very effective. Blend in-game and off-game activities (news updates and role plays) [3].

7. COLLABORATIVE PLAY

Team-based play and social interaction stimulates the release of oxytocin in our brains which is key to how we bond with others and creates strong feelings of contentment [2].

8. WORTHY CHALLENGES

Success in difficult tasks releases different endorphins producing feelings of well-being. Competition can enhance sense of achievement provided there are "no losers" [2,5].

9. FEEDBACK AND REWARDS

Anticipation of feedback and rewards stimulates the release of serotonin in our brains which contributes to feelings of well-being and happiness. Use 'theatre' in recognizing success [2].

10. TESTING, TESTING!

All forms of self-testing including teaching others are much more effective than simply acquiring knowledge (the "fluency illusion"). Testing before learning is also very effective [8].

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11. PROBLEM SOLVING

Creative problem solving, case studies and scenarios are one of the best ways to learn as they allow us to deepen learning by forcing us to try to apply newly acquired knowledge [8].

12. FACILITATED REFLECTION

Time for, and help with, reflection is vital. 'Informal learning' - reflecting and discussing our insights - is the best way to learn operational skills. Allow time for reflection and discussion [6].

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What we now know about learning from Neuroscience and Psychology

THE NEUROSCIENCE AND PSYCHOLOGY OF GAME-BASED LEARNING (GBL): 12 KEY ENABLERS

Infographic by www.dashboardsimulations.com

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COLLABORATIVE PLAY

Team-based play and social interaction stimulates the release of *oxytocin* in our brains which is key to how we bond with others and creates strong feelings of contentment. [2]

WORTHY CHALLENGES

Succeeding in difficult tasks stimulates the release of different *endorphins* which produce feelings of well-being. Competition can enhance sense of achievement but make sure there are "no losers". [2,5]

FEEDBACK AND REWARDS

Anticipation of feedback and rewards stimulates the release of *serotonin* in our brains which contributes to feelings of well-being and happiness. Use 'theatre' in recognizing success. [2]

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REFERENCES: 1. "A Simple Guide to Neurotransmitters" by Andy Brunning 2. "Introduction to Gamification for Customer Engagement" by Pete Jenkins 3. "Neuroscience and How Students Learn" by Daniela Kaufer 4. "Adrenaline, Cortisol, Norepinephrine: The Three Major Stress Hormones, Explained" by Sarah Klein 5. "Can neuroscience solve the mystery of how students learn?" by Ben Martynoga 6. "Informal Learning", Jay Cross, Pfeiffer, 2006 7. Management Simulator and Game Study, Kenworthy and Wong, 2005 8. "How we learn" by Benedict Carey 9. "Taking Serious Games Seriously in Education" by Kristen Dicerbo

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REFERENCES & FURTHER READING

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ABOUT THE AUTHOR

Ken Thompson is an expert practitioner, author and speaker on collaboration, high performing teams, change management, game-based learning, experiential learning and social learning. Ken's work has featured in major publications including The Guardian Newspaper, Wired Magazine, The Huffington Post and The Henry Ford Magazine. Ken has also spoken at many international events including TEDx, the Institute for Healthcare Improvement (IHI), Learn Tech (London) and NASA.

Ken is also the author of "The Systematic Guides" Series of books which provide concise practical guidance on the following important leadership topics:

- **A Systematic Guide to High Performing Teams (HPTs)**
- **A Systematic Guide to Game-Based Learning (GBL) in Organizational Teams**
- **A Systematic Guide to Business Acumen and Leadership using Dilemmas**
- **A Systematic Guide to Change Management**
- **A Systematic Guide to Collaboration and Competition in Organizations**
- **A Systematic Guide to Project Management**

All books are available on Amazon in paperback and kindle formats.

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