GAMIFICATION
Gimmick or game-changer?

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What is GAMIFICATION?

The incorporation of game mechanics to provide a framework that facilitates learning
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The incorporation of **game mechanics** to provide a **framework** that facilitates learning.
INTENDED LEARNING OUTCOME: Discuss the characteristics of major London rail terminals
Current teaching methods are not engaging students enough *(Green & Bavelier, 2012)*.

Provides opportunity to safely ‘learn through failure’ *(Tzourava & Zaharias, 2013)*.

Enhances traditional ‘softer’ skills (communication, teamwork, problem solving, leadership) which are becoming increasingly more important *(Imperial College Learning & Teaching Strategy)*.
Characteristics of a good game

- Construction
- Chronometry
- Collaboration
- Continuity
- Challenge
- Constraints
A caveat...

Minimising disengagement
Maximising involvement
## Task 1 (5 min; 3* points)

**Going to altitude**

In your envelope you’ll find details of your climbing group, a name card and a question, Think of a witty team name which you’ll need to lock-in your first task (*worth up to 8 points*). Once you’ve got your team name, complete your question and submit.

<table>
<thead>
<tr>
<th>Name</th>
<th>Occupation</th>
<th>Sex</th>
<th>Age</th>
<th>Height</th>
<th>Weight</th>
<th>Fitness</th>
<th>Medical History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akiiah</td>
<td>Singer</td>
<td>Female</td>
<td>21</td>
<td>155cm</td>
<td>52kg</td>
<td>Excellent</td>
<td>Anaemic</td>
</tr>
<tr>
<td>John</td>
<td>Train driver</td>
<td>Male</td>
<td>41</td>
<td>180cm</td>
<td>81kg</td>
<td>Excellent</td>
<td>None</td>
</tr>
<tr>
<td>Roy</td>
<td>Marketing manager</td>
<td>Male</td>
<td>38</td>
<td>170 cm</td>
<td>81kg</td>
<td>Very good</td>
<td>Migraines</td>
</tr>
<tr>
<td>Andrew</td>
<td>Fitness instructor</td>
<td>Male</td>
<td>27</td>
<td>187 cm</td>
<td>110kg</td>
<td>Excellent</td>
<td>Non Smoking COPD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Occupation</th>
<th>Sex</th>
<th>Age</th>
<th>Height</th>
<th>Weight</th>
<th>Fitness</th>
<th>Medical History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Claire</td>
<td>Office manager</td>
<td>Female</td>
<td>46</td>
<td>173 cm</td>
<td>80kg</td>
<td>Good</td>
<td>Hypertension (treated)</td>
</tr>
<tr>
<td>Ed</td>
<td>Accountant</td>
<td>Male</td>
<td>51</td>
<td>184 cm</td>
<td>90kg</td>
<td>Good</td>
<td>Type 2 diabetes</td>
</tr>
<tr>
<td>Nikita</td>
<td>Nurse</td>
<td>Female</td>
<td>33</td>
<td>160 cm</td>
<td>80kg</td>
<td>Very good</td>
<td>None</td>
</tr>
<tr>
<td>Omar</td>
<td>Investment banker</td>
<td>Male</td>
<td>22</td>
<td>175 cm</td>
<td>67kg</td>
<td>Very good</td>
<td>Mild Asthma</td>
</tr>
</tbody>
</table>

## Question 1

**How high is high altitude?**

**2400 m**
Oxygen
Used to support metabolic energy production

Oral gas

Nifedipine
Calcium channel blocker
Vasodilation of vascular smooth muscle

Amoxicillin (Flucloxacillin)
Antibiotic
To treat infection

Aspirin
NSAID
To prevent platelet adhesion, and treat fever and inflammation

Salbutamol
Short-acting β₂ agonist
Relaxation of airway smooth muscle

Sildenafil (Viagra®)
Phosphodiesterase inhibitor
Vasodilation of vascular smooth muscle

Dexamethasone
Corticosteroid
Steroid to alleviate symptoms of mountain sickness

Oxygen
Oral gas
Used to support metabolic energy production

Acetazolamide
Carbonic anhydrase inhibitor
Reduces H₂O + CO₂ ↔ H₂CO₃

Mannitol
Osmotic diuretic
Reduce intracranial pressure

Heparin (Warfarin)
Anticoagulant
To prevent formation of blood clots

Ramlipril
Ace inhibitor
Inhibition of angiotensin II synthesis

Propanolol
Beta blocker
SNS antagonist – blockade of β₁/β₂/β₃ receptors

Furosemide
Loop diuretic
Increases water loss from the loop of Henle

Warfarin

Lisinopril

Atenolol

Flucloxacillin

Everest ascent

Task 2 (10 min; 6 points)
Packing your bags
Inside the envelope you will find 13 medication names (green), 13 medication classes (yellow) and 13 drug mechanisms (red). Try and match each set (3 points). You must select eleven drugs that can help you treat altitude sickness, so you must choose two to discard (2 marks).
As you approach a village near 3000 m altitude you encounter an individual heading down the mountain. His name is Old Man Tengin. He is staggering and appears cyanotic. You attend to him and take some basic measurements with your kit: Hb: 218 g/L; \(S_\text{a}O_2\): 98%; \(HR_{\text{rest}}\): 95 bpm; Weight: 81 kg; Height: 173 cm; Ejection fraction: 65%; End-systolic volume: 43 mL.

Reference value: Hb binding capacity = 1.33 mLO₂/g Hb

**Question – Estimate his total blood volume. To help with this, think what a ‘typical blood volume’ and a ‘typical weight’ are.**

To estimate his total blood volume, we can use the empirical formula:

\[
\text{Blood Volume (in mL)} = \frac{71 \text{ mL/kg} \times \text{Weight (in kg)}}{1000} = \frac{71 \times 81}{1000} = 5.75 \text{ L}
\]

**Typically 5 L in 70 kg male**

\[
= 71 \text{ mL/kg} \times 71 \times 81 = 5.75 \text{ L}
\]

**Question – Calculate how much haemoglobin he has circulating in his blood.**

\[
5.75 \text{ L} \times (21.8 \text{ g/dL} \times 10) = 1254 \text{ g}
\]

**Question – Calculate his cardiac output?**

\[
43 \text{ mL/35\% (x100)} = 123 \text{ mL} - 43 \text{ mL} = 80 \text{ mL/beat} \times 95 \text{ beats/min} = 7.6 \text{ L/min}
\]
**Task 4 (10 min; 5 points)**

*Accommodation and acclimatisation*

Inside the envelope you will find eleven cards describing various stages of the accommodation and acclimatisation response to hypobaric hypoxia. Arrange them into the correct order.

Inside the envelope you will find eleven cards describing various stages of the accommodation and acclimatisation response to hypobaric hypoxia. Arrange them into the correct order and stick them to the board.

1. **↓ atmospheric O₂**
2. **↓ pₐO₂ and ↓ pₐCO₂**
3. **Hypoxia detected by carotid bodies**
4. **↓ pₐO₂**
5. **↑ ventilation**
6. **↑ HCO₃⁻ excretion via kidneys**
7. **↑ pₐO₂ and ↓ pₐCO₂**
8. **↑ ventilation**
9. **↑ pₐO₂ and ↓ pₐCO₂**
10. **↑ [H⁺] and ↓ pH**
11. **Hypoxia detected by carotid bodies**

- **↓ [H⁺] and ↑ pH**
- **↑ pₐO₂ and ↓ pₐCO₂**
- **↑ HCO₃⁻ excretion via kidneys**
- **↑ [H⁺] and ↓ pH**
Your group climb well for two days and reach 6000 m target with four hours to spare. Andrew recommends the group push on for another 400 m climb. Half of the group agree with this course of action.

Andrew gets frustrated and shouts wheezingly, ‘Come on! Even though I’ve just vomited and my head is pounding, I have a six-pack and I am getting up this mountain!’ He denies feeling fatigued and hasn’t had problems sleeping. You ask him politely to fill everyone’s water canteen, which he does... begrudgingly... zigzagging from side to side.

Once done, Andrew triumphantly exclaims “Me and Tom are keeping on with the climb, even if you guys stay here!”

The group begins to argue. As medical officer you have the final say. What action should you take? Justify your decision to the rest of the group stating key reasons. Record them below.
1. Compared to sea level, how would you expect an arterial blood gas to change after two weeks at base camp (5000 m)

A: pH: unchanged; PCO₂: high; BE: high; PO₂: low
B: pH: high; PCO₂: low; BE: high; PO₂: low
C: pH: unchanged; PCO₂: low; BE: low; PO₂: low
D: pH: high; PCO₂: high; BE: low; PO₂: low

↓ atmospheric O₂
↓ PₐO₂
↓ PₐCO₂
Hypoxia detected by carotid bodies
↑ ventilation
↑ PₐO₂ and ↓ PₐCO₂
↓ [H+] and ↑ pH
pH imbalance detected by carotid bodies
↑ HCO₃⁻ excretion via kidneys
↑ [H⁺] and ↓ pH
Everest Ascent

Task 6 (10 min; 15 points)
Yeti TBL

After struggling on up the mountain, your cerebral oedema and neurological function decline. As you near the summit you find a yeti doing TBL in a shack. You decide to play. Answer the five TBL questions enclosed. First guess = 3 points, second guess = 1 point, third guess = -1 point and fourth guess = -3 points (no answer = -3 points)

2. Look at the enclosed figure. What do you think the maximum altitude of permanent human habitation might be?
   A: 5500 m
   B: 5100 m
   C: 4300 m
   D: 4700 m
Everest Ascent

Task 6 (10 min; 15 points)
Yeti TBL

After struggling on up the mountain, your cerebral oedema and neurological function decline. As you near the summit you find a yeti doing TBL in a shack. You decide to play. Answer the five TBL questions enclosed. First guess = 3 points, second guess = 1 point, third guess = -1 point and fourth guess = -3 points (no answer = -3 points)

3. How many individual anatomical locations contain peripheral chemoreceptors involved with identifying hypoxia and stimulating an increase in ventilation?
A: 5
B: 4
C: 3
D: 2
4. Look at the blood sample results provided. Calculate the haemoglobin concentration.

A: 209 g/L
B: 189 g/L
C: 199 g/L
D: 219 g/L

_Hb can be calculated by multiplying the mean corpuscular haemoglobin (MCH) by the number of red cells_

\[
29.2 \times 7160000 = 209072000 \text{ pg/µL}
\]

Convert pg to g by diving by \(10^{12}\)

\[
0.0002091 \text{ g/µL}
\]

Convert µL to L by multiplying by \(10^6\)

\[
209.072 \text{ g/dL}
\]

\[
= 209 \text{ g/dL}
\]
5. Look at the blood sample results provided. Calculate the haematocrit.

A: 0.74
B: 0.64
C: 0.59
D: 0.69

Haematocrit (Hct) can be calculated by multiplying the mean cell volume (MCV) by the number of red cells

\[ \text{Hct} = \frac{\text{MCV} \times \text{Red cell count}}{100} \]

\[ 7160000 \text{ cells/µL} \times 89 \text{ fL/cell} = 637240000 \text{ fL/µL} \]

Convert fL to µL by dividing by 10^9

\[ 637240000 \text{ fL/µL} = 0.64 \text{ µL/µL} \]

= 0.64 (no units)

---

**Sample B**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Result</th>
<th>Normal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin (g/dL)</td>
<td>7.16</td>
<td>12 – 17</td>
</tr>
<tr>
<td>Red blood cell count (x10^6/µL)</td>
<td>7.16</td>
<td>4.1 – 5.6</td>
</tr>
<tr>
<td>White cell count (x10^3/µL)</td>
<td>6.5</td>
<td>3.8 – 10.8</td>
</tr>
<tr>
<td>Platelets (x10^3/µL)</td>
<td>312</td>
<td>140 – 415</td>
</tr>
<tr>
<td>Neutrophils (%)</td>
<td>54</td>
<td>40 – 74</td>
</tr>
<tr>
<td>Lymphocytes (%)</td>
<td>39</td>
<td>14 – 46</td>
</tr>
<tr>
<td>Monocytes (%)</td>
<td>4</td>
<td>4 – 13</td>
</tr>
<tr>
<td>Eosinophils (%)</td>
<td>3</td>
<td>0 – 7</td>
</tr>
<tr>
<td>Basophils (%)</td>
<td>0</td>
<td>0 – 3</td>
</tr>
<tr>
<td>Haematocrit (%)</td>
<td>0.36 – 0.50</td>
<td></td>
</tr>
<tr>
<td>MCV (fL)</td>
<td>89</td>
<td>80 – 98</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>29.2</td>
<td>27 – 34</td>
</tr>
<tr>
<td>MCHC (g/dL)</td>
<td>34.9</td>
<td>32 – 36</td>
</tr>
</tbody>
</table>
Everest Ascent: Results as feedback

- 1st: 29.4
- 2nd: 29.1
- 3rd: 28.1

Scores for various ascents and challenges.
Everest Ascent: Immersive elements
An ambulance crew are called to a young man who has been stabbed. On their arrival he responds only to painful stimuli, is making incomprehensible sounds, looks pale and has cold peripheries. He is tachycardic and although the crew cannot feel a radial pulse there is a weak carotid pulse. They administer oxygen, apply pressure to the wound in his upper leg, insert a venous cannula and give intra-venous fluids before rushing him to hospital.

On arrival to A&E he is met by the trauma team (clinical measurements shown below). Following the therapy given by the ambulance staff he is now opening his eyes spontaneously, is highly agitated/disorientated and keeps asking for, “something to drink”. The surgeons diagnose a laceration to his femoral artery and, after further pre-operative resuscitation, he is taken to theatre to have the laceration repaired. Following the operation he is transferred to Intensive care. Over the next 48 hours he regains consciousness, although remains highly confused, and only passes a few millilitres of urine.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>On admission</th>
<th>48 hours later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse (beats/minute)</td>
<td>120</td>
<td>75</td>
</tr>
<tr>
<td>Systemic arterial blood pressure (mmHg)</td>
<td>85/50</td>
<td>120/80</td>
</tr>
<tr>
<td>*Central venous pressure (cm saline with reference to the sternal angle)</td>
<td>-7</td>
<td>5</td>
</tr>
<tr>
<td>Whole blood Haemoglobin (g/dl)</td>
<td>13.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Plasma Urea (mM/L)</td>
<td>5.0</td>
<td>12.0</td>
</tr>
</tbody>
</table>

*Measured with a catheter in the superior vena cava

What are the normal values? Explain the symptoms and findings in the patient in terms of the underlying physiological mechanisms.
## Results

<table>
<thead>
<tr>
<th>Student population</th>
<th>Medicine</th>
<th>Biomedical Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students taught (n)</td>
<td>28</td>
<td>62</td>
</tr>
<tr>
<td>Students recruited (n)</td>
<td>8</td>
<td>11</td>
</tr>
</tbody>
</table>

- Focus group conducted by experienced independent researcher
- Transcribed & anonymised by independent researcher
- Analysed independently using NVIVO by two researchers

<table>
<thead>
<tr>
<th>Duration of focus group</th>
<th>53 min</th>
<th>47 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transcription length</td>
<td>6061 words</td>
<td>3892 words</td>
</tr>
<tr>
<td>Analysis</td>
<td>102 discrete nodes</td>
<td>88 discrete nodes</td>
</tr>
<tr>
<td></td>
<td>512 references</td>
<td>405 references</td>
</tr>
</tbody>
</table>
I do think that’s useful to make mistakes. I think that, when you make mistakes, I remember when someone made a mistake and then the other person, as in a group effort.

Learning from mistakes

Yeah I think it was probably redundant - the timer. [many agree]
I definitely felt a change in the atmosphere of the room when James said there’s going to be a timer for half an hour. Everyone sort of perked up a bit and sort of, maybe thought a bit more of it as a game.

...a really good learning experience because it really made us have to bring back everything we learnt throughout the course and try and put it all together to resolve the case. It helped us to revise and it was good. ...it made you think rather than having a passive session ...good for revising and stuff that we had been taught already

I remember a lot more of what we did compared to the other ones where we were just kind of just given information rather than us thinking about it. ...pulling out stuff from each lecture and then putting it all together it made everything we’ve learnt seem much more achievable

Active learning

Integration
**Results**

**Everest Ascent**

**Game dynamics**
- with no time(r) we would have been more laid back and less motivated [*students agree*]

**Group size & accessibility**
- “I thought it was a really good interactive way of learning and compared to a bland tutorial where essentially the professor would just lecture in a smaller amount of people. It allowed you to apply what you learned to solve real world problems. I think it was a good experience”
- ...maybe the questions on the iPad and everyone can see it.
- ...there was no way everyone can read

**Engagement**
- ...very interesting because we split up the task but we ended doing two methods. We got it in the end but it was quite interesting that we used different methods to do it. We got the right answer.

**Parallel tasks**
- There were some expected knowledge from pharmacology and last year’s physiology course. It was good that we went over it [*most agree*]. It was a good overview of everything.

**Integration**
- ...thought it made it harder to communicate with my group because we had to shout at each other and really come close to hear what they were saying

**Immersive elements**
- ...it depends how you learn. I think compared to a worksheet this will help me retain information [*some nods*]. Because you are actively doing the task for an hour.
- ...having the material physically and moving them around is very helpful [*many nod*]
Other games...

Digestion, absorption & obesity

Case 4
During a work experience placement in an obstructive sleep apnoea clinic your consultant sees Mrs H, a non-diabetic 39-year-old female, for her annual check-up. She is compliant with her continuous positive airway pressure (CPAP) device, which keeps her airway patent at night, so her nocturnal apnoeas are well controlled. However, she is keen to get off the device as the noise of the machine is keeping her husband up at night. She is keen to lose weight (2015: 142 kg; today: 148 kg) and has tried diet and exercise with little success. Her blood glucose is normal. She is reluctant to pursue surgical options and asked if there are any pharmacological treatments that may help.

Using the case 4 arrow, identify a suitable point on your flowchart where medication could contribute to the treatment of obesity.

orlistat
Would there be any side effects?

steatorrhoea
Non-teaching gamification: **ORIENTATIONOPOLY**

**Reynolds Building and Charing Cross campus**

**TASK 9: The Reynolds’ library: 150 pts**
The Reynolds’ library is one of the Faculty of Medicine libraries. Here, we'd like you to demonstrate effective use of the library resources. Try and find a book with ‘Anatomy’ in the title. Take it to one of the automated checking out machines near the entrance.
- Check the book out and print a receipt.

Use the stapler on the library help desk to staple the receipt to this answer booklet.

To return the book, drop it INTO the **BLUE BIN** by the elevators outside the library.

**TASK 10: Margravine Cemetery: 180 pts**
Adjacent to the Charing Cross campus is the Margravine cemetery, which accepted burials between 1868 and 1951. This graveyard will become very familiar to you if you travel between SK and CX using the Baron’s Court tube station.
Using the schematic below, you need to try and locate the following grave:

**Approximate location:**
- **Name:** John Stiles
- **Year of death:**

**Reynolds building**

**TASK 11: First floor mezzanine: 200 pts**
Find the Reynolds building main entrance, go in and up the main staircase. This should bring you out on the first floor, where there is a large open space with sofas. Go to the window, you’ll find lots of QR codes stuck to the windows. Scan the QR code that matches your team name, using the app on your iPad.

Eventually, you’ll be posed a question. Use the space below to write your answer.

Answer:  

**TASK 12: Room finder: 220 pts**
After the SAF building, the Reynolds building is one of our most versatile teaching sites, with twelve different teaching spaces. Some rooms are listed below, try and find them and look at the bottom right of the door. You’ll find a sticker with two letters on it. Write them below. Once you have all six letters, you’ll need to rearrange them to form a medical term.

- B1
- Communication
- Skills B
- R1

Answer:  

**Inspired by ‘Medical Monopoly’ by Giskin Day**
Non-teaching gamification: **SECRET LIBRARIAN**

Playful roleplay game where a group of students take on the role of an investigative librarian trying to uncover a plagiarism scandal

Supplements induction activities

- *Library catalogue use*
- *Resource location*
- *Referencing systems*
- *Bibliographies*
- *Plagiarism*
Non-teaching gamification: Untitled time management game
Conclusions

Gamified teaching, like any teaching method, receives a mixed reception. Structure needs careful consideration to minimise disengagement.

Gamification may be better suited to integrating topics, rather than new content.

Efficacy (compared with other approaches) is unclear. As with other active learning strategies, greatest benefit may be for lowest quartile.

If creating paper-based resources, plan the design carefully. ...to minimise how much laminating and cutting you need to do!
Take home message