**EIT 6412 – Gamified learning**

**Table 1: Characteristics of included studies**

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| **Study**  | **Study Design**  | **Setting**  | **Number of participants**  | **Outcome measures** | **Control group**  | **Intervention group** | **Gamification elements** | **Results** |
| Billner-Garcia, 20221 | Observational  | Nurses; USA | 19 | S (scoring rubric for NRP scenario, time to initiate PPV) | NA | Online access to game participant portal | "Story" and "quest" elements; inability to progress without perfect score | Scenario score: post better than pre, p=0.007; time to PPV: post better than pre, p=0.04;  |
| Boada, 20152 | RCT | Nursing students, Spain | 109 (IG 67; CG 42) | S (CPR performance) expressed as scaled score (%) | Standard training | Use of LISSA (online gamified platform) | Computer based competitive CPR performance | Improved scores in groups who used LISSA compared to those who didn’t (36 vs 47; p<0.05 and 36 vs 50, p<0.05) |
| Chang, 20193 | RCT | Healthcare providers, multinational | 920 (IG 601, CG 319) | S (CPR performance) | No access to leaderboard | Availability of leader board | Leaderboard | No effect |
| Cutumisu, 20194 | Observational | Healthcare providers; Canada | 30 | K (overall score 0-16 points) | NA | RETAIN (board game designed to teach NRP knowledge) | Score-based board game | Overall score: pre 49% vs post 61% (p<0.001) |
| Gordon, 19955 | Observational | Healthcare providers; USA | 11 | A (Likert scale survey on effectiveness) | NA | Card game involving NRP knowledge | Card game played between two teams | 4.2 - 4.8 mean scores on 5 point Likert scale |
| Gutierrez-Puertas, 20216 | RCT | Nursing students; Spain | 184 (92 per group) | K (ad hoc questionnaire; 10 MCQs) | Standard 2 hour training | Training with 90 mins use of game | Phone based app using random keywords that subject gives clues to teammates to identify | Pre-intervention to post intervention: CG 6.9 + 1.5, IG 7.7 + 1.4 (p<0.05); 3 weeks post training CG 7.8 + 6.4, IG 9.5 + 0.9 (p<0.05) |
| Hu, 20217 | Observational | Medical students; China | 81 (IG 41, CG 40) | K (test; format not described well) | Simulation based NRP training | Same with pre-training access to game | NEOGAMES (screen based NRP game with point system) | Immediate post training score: IG 98 + 3; CG 95 + 7 (NS); 6 months post training: IG 87 + 12; CG 63 + 15 (p<0.001) |
| King, 20238 | Observational | Pediatric nurses, USA | 22 | S (preparation of epinephrine dose); K (correct dose); A (comfort) | NA | Repeated practice and testing with leaderboard for best times | Leaderboard | Average decrease in time 27 sec (p=0.02); proportion completing task in < 2 mins from 23% to 59% (p=0.03); proportion knowing correct concentration 19% to 73% (p<0.001); comfort improved by mean 3.6 of ten points (p<0.001) |
| MacKinnon, 20159 | RCT | HCPs, UK | 171 (IG 90, CG 81) | S (CPR performance score) | No refresher training over 6 mos. | Self-motivated CPR refresher training over 6 mos. | Leaderboard | CPR performance change significant in IG (p<0.001) |
| Otero-Agra, 201910 | RCT | High school students, Spain | 489 (IG 151; CGs groups 338) | S (CPR parameters) | 3 groups: EVA (training with evaluation for grade); VFC (noncompulsory w visual feedback); TC (noncompulsory, no feedback) | GAM: team based competition | Competition btw groups of 4 students with scores displayed | QCPR score: GAM 90 + 8; EVA 85 + 20 (p=0.03); VFC 82 + 21 (p<0.001); TC 64 + 28(p<0.001) |
| Phungoen, 202011 | RCT | 5th yr med students; Thailand | 105 (IG 53; CG 52) | K (2 MCQ tests, one on ALS algorithm, one on general ALS knowledge); S (ALS scenario score); A (confidence post course) | 2 day ALS course | Use of game before and during 2 day ALS course | Resus Days: smartphone app with video and point based resusc scenarios | ALS algorithm test: IG 17 + 2 vs CG 16 + 2 (p=0.01); ALS knowledge IG 22 + 2 vs CG 22 + 3 (p=0.45); Skill test passing score IG 79% vs CG 66% (p=0.09); Confidence IG 8 + 1 vs CG 8 + 2 (p=0.51) |
| Semeraro, 201712 | Observational (before and after) | High school students, Italy | 65 | S (CPR parameters) immediately post course and at 3 months | NA | Use of game interface during CPR "tournament" | Relive: screen based interface with video feedback | Immediate post course: CC depth 45 + 8 mm vs baseline 31 + 12 mm (p<0.01); CC rate 111 + 10 vs baseline 94 + 32 (p<0.01); 3 month retention: depth 46 + 15, rate 131 + 37 (vs baseline p<0.01, vs course NS)  |
| Toft, 202213 | Observational | High school students, USA | 92 (IG 47, CG 45) | S (CPR overall performance); K (questions re: recognition of OHCA) | AHA Hands Only CPR Course | Heart Class (HC) – online competition platform | 2 teams competing at questions and CPR performance | 6 mos. post training: CPR score IG 23%, CG 16% (p<0.05); recognition IG 12%, CG 7% (NS);  |

Abbreviations: NRP: Neonatal Resuscitation Program; PPV: positive pressure ventilation; NA: not applicable; RCT: randomized controlled trial; IG: intervention group; CG: control group; CPR: cardiopulmonary resuscitation; S: skill; K: knowledge; A: attitude; MCQ: multiple choice questions; ALS: advanced life support; OHCA: out-of-hospital cardiac arrest

**Table 2: Assessment of bias tables**

RCTs (Cochrane ROB)

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| **1st Author** | **Year** | **Randomization** | **Deviations from interventions** | **Missing data** | **Outcome measurement** | **Outcome reporting** | **Overall** |
| Boada2 | 2015 | Some concerns | High | High | High | Some concerns | ***High*** |
| Chang3 | 2019 | Low | Some concerns | Low | Some concerns | Low | ***Some concerns*** |
| Gutierrez-Puertas6 | 2021 | Some concerns | Some concerns | Low | Some concerns | Low | ***Some concerns*** |
| MacKinnon9 | 2015 | Low | Low | Low | Some concerns | Low | ***Low*** |
| Otero-Agra10 | 2019 | Low | Some concerns | Low | Some concerns | Low | ***Some concerns*** |
| Phungoen11 | 2020 | Low | Some concerns | Low | Low | Low | ***Some concerns*** |

Observational studies (ROBINS-I)

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| **1st Author** | **Year** | **Confounding** | **Participant selection** | **Intervention classification** | **Deviations from interventions** | **Missing data** | **Outcome measurement** | **Outcome reporting** | **Overall** |
| Billner-Garcia1 | 2022 | Serious | Low | Low | Low | Low | Low | Low | ***Serious*** |
| Cutumisu4 | 2019 | Serious | Low | Low | Low | Low | Low | Low | ***Serious*** |
| Gordon5 | 1995 | Serious | Low | Low | Low | Low | Serious | Low | ***Serious*** |
| Hu7 | 2021 | Serious | Low | Low | Low | Low | Low | Low | ***Serious*** |
| King8 | 2023 | Serious | Low | Low | Low | Low | Low | Low | ***Serious*** |
| Semeraro12 | 2017 | Moderate | Low | Low | Low | Low | Low | Low | ***Moderate*** |
| Toft13 | 2022 | Serious | Low | Low | Low | Low | Low | Low | ***Serious*** |