Simulations

Over the past 25 years, the use of simulations has been found to be engaging as learning and assessment tools (Behrens, DiCerbo, & Ferrara, 2012; Gegenfurtner, Quesada-Pallarès, & Knogler, 2014; Mitchell & Savell-Smith, 2004; Pai-Hsing Wu et al., 2014; Quellmalz et al., 2012; Shute & Ventura, 2013). A digital simulation can be defined as a technology modeling a system or a process where a user can manipulate parameters in the system (De Jong & Van Joolingen, 1998). In a simulation, processes, systems, and functions of real-life phenomena are simulated in real time in an authentic and complex manner, which in turn helps learners to critically engage with the learning material (Holladay & Quiñones, 2003). Common examples of simulations involve pilot training in flight simulators (Jacobs, Prince, Hays & Salas, 1990; Wong, Meyer, Timson, Perfect, & White, 2012), decision making in business simulations (Lainema & Nurmi, 2006; Siewiorek & Gegenfurtner, 2010), medical diagnosis using simulated patients (Consorti, Mancuso, Nocioni, & Piccolo, 2012; Cook, Erwin, & Triola, 2010; Iseli, Koenig, Lee, & Wainess, 2010), and physics learning in 2D physics simulation environments (Shute & Ventura, 2013). Digital simulations are becoming increasingly popular in professional training for developing complex cognitive skills (Helle et al., 2011; Mayer, Dale, Fraccastoro, & Moss, 2011; Rogers, 2011; Siewiorek, Gegenfurtner, Lainema, Saarinen, & Lehtinen, 2013; Tynjälä, Häkkinen, & Hämäläinen, 2014; Wang & Wu, 2008).

Best practices for designing simulations for learning include:

- Match simulations to learning goals
- Make learning essential to simulation progress
- Build in proven instructional strategies
- Build in guidance and structure
- Manage complexity
- Make relevance salient

Assessment: Software simulation
Instruction: Active learning experience
Robust Technology: Flight simulator
Simple Technology: 2D physics simulations in a digital environment
Content Support: Using the Evidence-Centered Design (ECD) approach

• Attitude
• Behavior
• Motivation
• Self-regulation
### SELF-ASSESSMENT INSTRUMENT

<table>
<thead>
<tr>
<th>Principle Criteria</th>
<th>Integration (4-5 points)</th>
<th>Exploration (2-3 points)</th>
<th>Consideration (1 point)</th>
<th>Not Applicable (0 Points)</th>
<th>Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>Strong application of technology to model a system or process</td>
<td>Some application of technology to model a system or process</td>
<td>Poor application of technology to model a system or process</td>
<td>Does NOT use effectively or is not a related activity</td>
<td>= _____</td>
</tr>
<tr>
<td></td>
<td>Strong integration of user control to manipulate the simulation</td>
<td>Some integration of user control to manipulate the simulation</td>
<td>Poor integration of user control to manipulate the simulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strong use of simulation to engage learners in an authentic context</td>
<td>Some use of simulation to engage learners in an authentic context</td>
<td>Poor use of simulation to engage learners in an authentic context</td>
<td></td>
<td></td>
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<tr>
<td><strong>Model</strong></td>
<td>Strong use of simulation to foster experimentation, discovery, construction, and collaboration</td>
<td>Some use of simulation to foster experimentation, discovery, construction, and collaboration</td>
<td>Poor use of simulation to foster experimentation, discovery, construction, and collaboration</td>
<td>Does NOT use effectively or is not a related activity</td>
<td>= _____</td>
</tr>
<tr>
<td></td>
<td>Strong use of simulation to conduct authentic tasks within a situated environment</td>
<td>Some use of simulation to conduct authentic tasks within a situated environment</td>
<td>Poor use of simulation to conduct authentic tasks within a situated environment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **Design**         | Strong selection of an appropriate simulation type for the context  
• Virtual world  
• Virtual modeling  
• Experimental sandbox  
• Reactive branching  
• Adaptive branching | Some selection of an appropriate simulation type for the context  
• Virtual world  
• Virtual modeling  
• Experimental sandbox  
• Reactive branching  
• Adaptive branching | Poor selection of an appropriate simulation type for the context  
• Virtual world  
• Virtual modeling  
• Experimental sandbox  
• Reactive branching  
• Adaptive branching | Does NOT use effectively or is not a related activity | = _____ |
|                    | Strong evaluation of design risks to optimize the simulation | Some evaluation of design risks to optimize the simulation | Poor evaluation of design risks to optimize the simulation |                           |              |
|                    | Strong use of evidence-based principles to design the simulation | Some use of evidence-based principles to design the simulation | Poor use of evidence-based principles to design the simulation |                           |              |
| **Assessment**     | Strong application of assessment within the simulation environment | Some application of assessment within the simulation environment | Poor application of assessment within the simulation environment | Does NOT use effectively or is not a related activity | = _____ |
|                    | Strong evidence of value-added validity beyond traditional assessments | Some evidence of value-added validity beyond traditional assessments | Poor evidence of value-added validity beyond traditional assessments |                           |              |
|                    | Strong use of both product and process data for assessment and feedback | Some use of both product and process data for assessment and feedback | Poor use of both product and process data for assessment and feedback |                           |              |

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