1: Definition of the six eLearning categories

Six broad categories of eLearning interventions, based on the technologies employed. The categories were defined as follows:

• Offline computer-based eLearning: standalone applications where internet or intranet connections are not required for the delivery of the learning activities. The main tasks of the eLearning software in this category are usually performed on a PC or laptop. The delivery channels are usually CD-ROM or USB memory sticks. Alternatively, the delivery mode of the software can be via a networked connection, as long as the learning activities do not rely on this connection.

• Online and local area network-based eLearning: interventions that use the transmission control protocol (TCP) and the internet protocol (IP) to provide the full functionalities of the educational intervention. As implied by the terminology used, the delivery channels are usually the internet or a local area network.

• Psychomotor skills trainer: technology that will develop fine motor coordination skills and techniques in education, such as the precise use of instruments of tools.

• Virtual reality environments: computer-generated representations of a real or artificial environment. This can be interacted with by external involvement, allowing for a first-person active learning experience.

• Digital game-based learning: the application of game principles and mechanics in non-game contexts to engage users in solving problems and improve their engagement, attitudes, motivation and knowledge.

• mLearning: any eLearning intervention that uses handheld, mobile devices to deliver educational content such as a mobile phone, iPod or tablet.
2: Fields included in the data extraction form

1. Study ID
2. Journal where the study was published
2.1. Type of publication
2.2. Authors’ affiliation
3. Study design as specified in the report
3.1. Study aims & objectives
3.2. Countries where the study was conducted
3.3. WHO region
3.4. World Bank income category
3.5. Study start date
3.6. Study end date
3.7. Method of comparison
3.8. Total number of participants invited to take part in the study
4. Total number of participants who agreed to take part in the study
4.1. Total number of participants meeting the inclusion criteria for participation in the study
4.2. Total number of participants included in the study
4.3. If cluster RCT, total number of clusters initially included in the study
4.4. If cluster RCT, total number of clusters randomised
4.5. Inclusion criteria
4.6. Exclusion criteria
4.7. Total number of experimental groups (including the control group)
4.8. Were groups tested for baseline differences?
4.9. If there were baseline differences, please specify what the difference was
4.10. Indicate the type of degree or qualification that participants were pursuing
5. If other, please specify:
5.1. Year of study within the anticipated degree or qualification
5.5. Control group
5.5.1. Total number of participants/clusters allocated to the control group
5.5.2. Mean age (standard deviation) of the participants in the control group
5.5.3. Name of educational intervention used as control
5.5.4. Description of the control condition
5.5.5. Field of study
5.6.6. Exposure to the control condition during the whole study
5.5.7. Total exposure time to the intervention
5.5.8. Type of technology/devices used to deliver the intervention
5.5.9. Delivery approach of the intervention
If other, please specify:
5.5.10. Was the usual delivery mode of the assessment changed?
5.5.11. If yes, please specify
5.5.12. Was the delivery mode of the assessment uniform across all the experimental groups?

5.6. Intervention group I
5.6.1. Total number of participants/clusters allocated to this intervention group.
5.6.2. Mean age (standard deviation) of the participants in this intervention group
5.6.3. Name of educational intervention used in this intervention group
5.6.4. Description of this intervention condition
5.6.5. Field of study
5.6.6. Exposure to this intervention condition during the whole study
5.6.7. Total exposure time to the intervention
5.6.8. Type of technology/devices used to deliver the intervention
5.6.9. Delivery approach of the intervention
If other, please specify:
5.6.10. Was the usual delivery mode of the assessment changed?
5.6.11. If yes, please specify
5.6.12. Was the delivery mode of the assessment uniform across all the experimental groups?

5.7. Intervention group II
5.7.1. Total number of participants/clusters allocated to this intervention group.
5.7.2. Mean age (standard deviation) of the participants in this intervention group
5.7.3. Name of educational intervention used in this intervention group
5.7.4. Description of this intervention condition
5.7.5. Field of study
5.7.6. Exposure to this intervention condition during the whole study
5.7.7. Total exposure time to the intervention
5.7.8. Type of technology/devices used to deliver the intervention
5.7.9. Delivery approach of the intervention
If other, please specify:
5.7.10. Was the usual delivery mode of the assessment changed?
5.7.11. If yes, please specify
5.7.12. Was the delivery mode of the assessment uniform across all the experimental groups?

5.8. Intervention group III
5.8.1. Total number of participants/clusters allocated to this intervention group.
5.8.2. Mean age (standard deviation) of the participants in this intervention group
5.8.3. Name of educational intervention used in this intervention group
5.8.4. Description of this intervention condition
5.8.5. Field of study
5.8.6. Exposure to this intervention condition during the whole study
5.8.7. Total exposure time to the intervention
5.8.8. Type of technology/devices used to deliver the intervention
5.8.9. Delivery approach of the intervention
If other, please specify:
5.8.10. Was the usual delivery mode of the assessment changed?
5.8.11. If yes, please specify
5.8.12. Was the delivery mode of the assessment uniform across all the experimental groups?
If more than 4 intervention groups (including the control group), please copy and paste the relevant cells as needed

6.1. Was 'Knowledge' measured? - If not, please go to section 6.2.
6.1.1. Instrument or measure used to assess knowledge - as specified by the study authors
6.1.2. Is this a validated instrument?
6.2. Were 'Skills' measured? - If not, please go to section 6.3.
6.2.1. Instrument or measure used to assess skills - as specified by the study authors
6.2.2. Is this a validated instrument?

6.3. Were 'Attitudes' measured? - If not, please go to section 6.4.

6.3.1. Instrument or measure used to assess attitudes - as specified by the study authors

6.3.2. Is this a validated instrument?

6.4. Was 'Student satisfaction' measured? - If not, please go to section 6.5.

6.4.1. Instrument or measure used to assess student satisfaction - as specified by the study authors

6.4.2. Is this a validated instrument?

6.5. Was an economic evaluation of the eLearning intervention performed?

6.5.1. Were quantitative indicators like costs, investments, hardware, software, license fees and benefits/savings of the eLearning intervention measured?

6.5.2. Was the urgency of the eLearning intervention (i.e., due to a new regulation or organisational demand) mentioned?

6.5.3. Were qualitative-strategic indicators of the eLearning intervention like quality and performance improvements measured?

6.5.4. Were external factors of the eLearning intervention like synergy effects or economies of scope measured?

6.5.5. Please list any additional economic indicators that were measured

7.1. Selection bias

7.1.1. Random sequence generation

7.1.1.1. Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups

7.1.1.2. Please indicate your judgement

7.1.2. Allocation concealment

7.1.2.1. Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen in advance of, or during, enrolment

7.1.2.2. Please indicate your judgement

7.2. Performance bias

7.2.1. Blinding of participants and personnel

7.2.1.1. Describe all measures used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective

7.2.1.2. Please indicate your judgement

7.3. Detection bias
7.3.1. Blinding of outcome assessment

7.3.1.1. Describe all measures used, if any, to blind outcome assessors from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.

7.3.1.2. Please indicate your judgement.

7.4. Attrition bias

7.4.1. Incomplete outcome data

7.4.1.1. Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomized participants), reasons for attrition/exclusions where reported, and any re-inclusions in analyses performed by the review authors.

7.4.1.2. Please indicate your judgement.

7.5. Reporting bias

7.5.1. Selective reporting

7.5.1.1. State how the possibility of selective outcome reporting was examined by the review authors, and what was found.

7.5.1.2. Please indicate your judgement.

7.6. Other bias

7.6.1. Other source of bias

7.6.1.1. State any important concerns about bias not addressed in the other domains in the tool.

7.6.1.2. Please indicate your judgement.

8.1. Recruitment bias

8.1.1. Please describe any evidence of recruitment bias.

8.2. Baseline imbalances

8.2.1. Please describe any evidence of baseline imbalances.

8.3. Loss of clusters

8.3.1. Please indicate any evidence of risk of bias due to loss of clusters.

8.4. Incorrect analysis

8.4.1. Please indicate any evidence of incorrect analysis.

9.1. Control group

9.1.1. Outcome reported

9.1.2. Measure of effect size (as measured by the study authors).
### Outcome Reported

<table>
<thead>
<tr>
<th>Measure of effect size (as measured by the study authors)</th>
<th>Measure of dispersion (as measured by the study authors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1.1. Outcome reported</td>
<td>9.1.3. Measure of dispersion (as measured by the study authors)</td>
</tr>
<tr>
<td>9.1.2. Measure of effect size (as measured by the study authors)</td>
<td>9.1.3. Measure of dispersion (as measured by the study authors)</td>
</tr>
</tbody>
</table>

If more than one outcome was reported, please insert more cells here and copy and paste the relevant data entry boxes.

### Intervention I group

<table>
<thead>
<tr>
<th>Measure of effect size (as measured by the study authors)</th>
<th>Measure of dispersion (as measured by the study authors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.2.1. Outcome reported</td>
<td>9.2.3. Measure of dispersion (as measured by the study authors)</td>
</tr>
<tr>
<td>9.2.2. Measure of effect size (as measured by the study authors)</td>
<td>9.2.3. Measure of dispersion (as measured by the study authors)</td>
</tr>
<tr>
<td>9.2.1. Outcome reported</td>
<td>9.2.3. Measure of dispersion (as measured by the study authors)</td>
</tr>
<tr>
<td>9.2.2. Measure of effect size (as measured by the study authors)</td>
<td>9.2.3. Measure of dispersion (as measured by the study authors)</td>
</tr>
</tbody>
</table>

If more than one outcome was reported, please insert more cells here and copy and paste the relevant data entry boxes.

### Intervention II group

<table>
<thead>
<tr>
<th>Measure of effect size (as measured by the study authors)</th>
<th>Measure of dispersion (as measured by the study authors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.3.1. Outcome reported</td>
<td>9.3.3. Measure of dispersion (as measured by the study authors)</td>
</tr>
<tr>
<td>9.3.2. Measure of effect size (as measured by the study authors)</td>
<td>9.3.3. Measure of dispersion (as measured by the study authors)</td>
</tr>
<tr>
<td>9.3.1. Outcome reported</td>
<td>9.3.3. Measure of dispersion (as measured by the study authors)</td>
</tr>
</tbody>
</table>
9.3.2. Measure of effect size (as measured by the study authors)
9.3.3. Measure of dispersion (as measured by the study authors)
9.3.1. Outcome reported
9.3.2. Measure of effect size (as measured by the study authors)
9.3.3. Measure of dispersion (as measured by the study authors)
9.3.1. Outcome reported
9.3.2. Measure of effect size (as measured by the study authors)
9.3.3. Measure of dispersion (as measured by the study authors)
If more than one outcome was reported, please insert more cells here and copy and paste the relevant data entry boxes.

9.4. Intervention III group
9.4.1. Outcome reported
9.4.2. Measure of effect size (as measured by the study authors)
9.4.3. Measure of dispersion (as measured by the study authors)
9.4.1. Outcome reported
9.4.2. Measure of effect size (as measured by the study authors)
9.4.3. Measure of dispersion (as measured by the study authors)
If more than one outcome was reported, please insert more cells here and copy and paste the relevant data entry boxes.

9.5. Comparison I
9.5.1. Please indicate the intervention groups being compared
9.5.2. Please indicate the outcomes being compared
9.5.3. Statistical test used for the comparison
9.5.4. Result of the test
9.5.5. P value / Confidence intervals

9.6. Comparison II
9.6.1. Please indicate the intervention groups being compared
9.6.2. Please indicate the outcomes being compared
9.6.3. Statistical test used for the comparison
9.6.4. Result of the test
9.6.5. P value / Confidence intervals

9.7. Comparison III
9.7.1. Please indicate the intervention groups being compared
9.7.2. Please indicate the outcomes being compared
9.7.3. Statistical test used for the comparison
9.7.4. Result of the test
9.7.5. P value / Confidence intervals

9.8. Comparison IV
9.8.1. Please indicate the intervention groups being compared
9.8.2. Please indicate the outcomes being compared
9.8.3. Statistical test used for the comparison
9.8.4. Result of the test
9.8.5. P value / Confidence intervals

9.9. Comparison V
9.9.1. Please indicate the intervention groups being compared
9.9.2. Please indicate the outcomes being compared
9.9.3. Statistical test used for the comparison
9.9.4. Result of the test
9.9.5. P value / Confidence intervals

9.9. Comparison V
9.9.1. Please indicate the intervention groups being compared
9.9.2. Please indicate the outcomes being compared
9.9.3. Statistical test used for the comparison
9.9.4. Result of the test
9.9.5. P value / Confidence intervals

9.9. Comparison V
9.9.1. Please indicate the intervention groups being compared
9.9.2. Please indicate the outcomes being compared
9.9.3. Statistical test used for the comparison
9.9.4. Result of the test
9.9.5. P value / Confidence intervals
For each comparison conducted in the study, please copy and paste the cells as appropriate

10.1. Organisational setting
10.2. Technological infrastructure
10.3. Instructional Systems Design and Curriculum development
10.4. Delivery
10.5. Advantages of eLearning - as reported by the study authors
10.6. Disadvantages of eLearning - as reported by the study authors

11.1. Source of financing - as reported by the study authors
11.2. Did the intervention undergo a formal accreditation process within the host institution?
11.3. If yes, please describe
11.4. Was the eLearning intervention developed for this study consequently adopted as a formal method for the delivery of education at the host institution?
11.5. If yes, please specify

12.1. Study conclusions - as stated by the study authors
12.2. Limitations of the study - as reported by the study authors
12.3. Was contact with the study authors sought? - If No, please go to section 12.5
12.4. Please indicate the nature of the information requested from the study authors
12.5. Please indicate the results of the request for information
12.6. Additional notes
### Results of electronic searches

<table>
<thead>
<tr>
<th>Database</th>
<th>Before de-duplication</th>
<th>After de-duplication</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDLINE</td>
<td>941</td>
<td>806</td>
</tr>
<tr>
<td>EMBASE</td>
<td>3206</td>
<td>3123</td>
</tr>
<tr>
<td>PsycINFO</td>
<td>334</td>
<td>334</td>
</tr>
<tr>
<td>Web of Knowledge</td>
<td>6993</td>
<td>4099</td>
</tr>
<tr>
<td>ERIC</td>
<td>146</td>
<td>146</td>
</tr>
<tr>
<td>CENTRAL</td>
<td>588</td>
<td>584</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12208</strong></td>
<td><strong>9092</strong></td>
</tr>
</tbody>
</table>
### 4: Characteristics of included studies for online computer-based eLearning

<table>
<thead>
<tr>
<th>Study ID</th>
<th>Study Design</th>
<th>Location</th>
<th>Year of Study</th>
<th>Total Number</th>
<th>Characteristics</th>
<th>Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>RCT</td>
<td>USA</td>
<td>2000</td>
<td>60</td>
<td>OSR students received OSR, do not have access to student workbooks, use all usual academic resources, academic research staff</td>
<td>Yearbook + Knowledge, several non-tutorials</td>
</tr>
<tr>
<td>B</td>
<td>RCT</td>
<td>USA</td>
<td>2000</td>
<td>50</td>
<td>OSR students received OSR, do not have access to student workbooks, use all usual academic resources, academic research staff</td>
<td>Yearbook + Knowledge, several non-tutorials</td>
</tr>
<tr>
<td>C</td>
<td>RCT</td>
<td>USA</td>
<td>2000</td>
<td>30</td>
<td>OSR students received OSR, do not have access to student workbooks, use all usual academic resources, academic research staff</td>
<td>Yearbook + Knowledge, several non-tutorials</td>
</tr>
<tr>
<td>D</td>
<td>RCT</td>
<td>USA</td>
<td>2000</td>
<td>20</td>
<td>OSR students received OSR, do not have access to student workbooks, use all usual academic resources, academic research staff</td>
<td>Yearbook + Knowledge, several non-tutorials</td>
</tr>
</tbody>
</table>

### Notes
- **Characteristics:**
  - OSR students received OSR, do not have access to student workbooks, use all usual academic resources, academic research staff.
  - Knowledge, several non-tutorials.
- **Interventions:**
  - Yearbook + Knowledge, several non-tutorials.
<table>
<thead>
<tr>
<th>Study ID</th>
<th>Method</th>
<th>Participants</th>
<th>Interventions</th>
<th>Time and Test User(s)</th>
<th>Test Footnotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cochrane 2009</td>
<td>RCT</td>
<td>Taiwan</td>
<td>GS students</td>
<td>OS students had access to an online learning environment on the Internet, which was based on the study. GS students had access to a website, while KS students had access to a website. KS students used their remote sites to receive instructions on the test.</td>
<td>1 week</td>
</tr>
<tr>
<td>Cochrane 2009</td>
<td>RCT</td>
<td>Japan</td>
<td>OS students</td>
<td>OS students received an online course and an additional workshop in the test and social skills. KS students received a video in the test and social skills.</td>
<td>1 week</td>
</tr>
<tr>
<td>Cochrane 2009</td>
<td>RCT</td>
<td>Korea</td>
<td>OS students</td>
<td>OS students received an online course and an additional workshop in the test and social skills. KS students received a video in the test and social skills.</td>
<td>1 week</td>
</tr>
<tr>
<td>Cochrane 2009</td>
<td>RCT</td>
<td>United States</td>
<td>OS students</td>
<td>OS students received an online course and an additional workshop in the test and social skills. KS students received a video in the test and social skills.</td>
<td>1 week</td>
</tr>
<tr>
<td>Cochrane 2009</td>
<td>RCT</td>
<td>United States</td>
<td>OS students</td>
<td>OS students received an online course and an additional workshop in the test and social skills. KS students received a video in the test and social skills.</td>
<td>1 week</td>
</tr>
<tr>
<td>Cochrane 2009</td>
<td>RCT</td>
<td>United States</td>
<td>OS students</td>
<td>OS students received an online course and an additional workshop in the test and social skills. KS students received a video in the test and social skills.</td>
<td>1 week</td>
</tr>
<tr>
<td>Cochrane 2009</td>
<td>RCT</td>
<td>United States</td>
<td>OS students</td>
<td>OS students received an online course and an additional workshop in the test and social skills. KS students received a video in the test and social skills.</td>
<td>1 week</td>
</tr>
<tr>
<td>Cochrane 2009</td>
<td>RCT</td>
<td>United States</td>
<td>OS students</td>
<td>OS students received an online course and an additional workshop in the test and social skills. KS students received a video in the test and social skills.</td>
<td>1 week</td>
</tr>
<tr>
<td>Publica</td>
<td>Issue</td>
<td>Country</td>
<td>Ethnicity</td>
<td>Field</td>
<td>University</td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
<td>----------</td>
<td>------------</td>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>RCT</td>
<td>RCT</td>
<td>Thailand</td>
<td>Traditional</td>
<td>RCT</td>
<td>Thailand</td>
</tr>
<tr>
<td>USA</td>
<td>USA</td>
<td>Germany</td>
<td>Traditional</td>
<td>USA</td>
<td>Germany</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL NUMBER</th>
<th>SECONDARY</th>
<th>THIRDARY</th>
<th>FOURTHARY</th>
<th>RESEARCH METHODS</th>
<th>YEAR</th>
<th>HEALTHCARE SPECIALTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>2012</td>
<td>2013</td>
<td>2014</td>
<td>Research Methods</td>
<td>2015</td>
<td>Pharmacy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>TIME AND TECHNOLOGY</th>
<th>TEST OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Methods</td>
<td>Technology</td>
<td>Outcomes</td>
</tr>
<tr>
<td>Study Design</td>
<td>Implementation</td>
<td>Analysis</td>
</tr>
<tr>
<td>Sample Size</td>
<td>Methods</td>
<td>Results</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>Instruments</td>
<td>Effectiveness</td>
</tr>
<tr>
<td>Quality Control</td>
<td>Measurement</td>
<td>Significance</td>
</tr>
<tr>
<td>Ethics</td>
<td>Documentation</td>
<td></td>
</tr>
<tr>
<td>SDM</td>
<td>Reporting</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- RCT: Randomized Controlled Trial
- USA: United States of America
- Germany
- Thailand
- Traditional
- Research Methods
- Year of Study
- Healthcare Specialty
<table>
<thead>
<tr>
<th>Location</th>
<th>Study Design</th>
<th>Total Number</th>
<th>Year of Study</th>
<th>Healthcare Specialty</th>
<th>Characteristics</th>
<th>Time and Technology</th>
<th>Test / Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>RCT</td>
<td>3</td>
<td>Second year</td>
<td>Medicine</td>
<td>Knowledge...</td>
<td>Computer...</td>
<td>Student...</td>
</tr>
<tr>
<td>Canada</td>
<td>RCT</td>
<td>3</td>
<td>Third year</td>
<td>Medicine</td>
<td>Knowledge...</td>
<td>Computer...</td>
<td>Student...</td>
</tr>
<tr>
<td>USA</td>
<td>RCT</td>
<td>3</td>
<td>Fourth year</td>
<td>Medicine</td>
<td>Knowledge...</td>
<td>Computer...</td>
<td>Student...</td>
</tr>
<tr>
<td>USA</td>
<td>RCT</td>
<td>3</td>
<td>Second year</td>
<td>Dentistry</td>
<td>Knowledge...</td>
<td>Computer...</td>
<td>Student...</td>
</tr>
<tr>
<td>USA</td>
<td>RCT</td>
<td>3</td>
<td>Third year</td>
<td>Medicine</td>
<td>Knowledge...</td>
<td>Computer...</td>
<td>Student...</td>
</tr>
<tr>
<td>USA</td>
<td>RCT</td>
<td>3</td>
<td>Fourth year</td>
<td>Medicine</td>
<td>Knowledge...</td>
<td>Computer...</td>
<td>Student...</td>
</tr>
</tbody>
</table>

**Note:** The table contains data from various studies comparing traditional and online learning methods in different healthcare specialties. Each row represents a different study with details on location, study design, total number of participants, year of study, healthcare specialty, characteristics, time and technology, and test outcomes.
<table>
<thead>
<tr>
<th>Variables</th>
<th>Study Design</th>
<th>Location</th>
<th>Comparison</th>
<th>Total Number</th>
<th>Year of Study</th>
<th>Healthcare Specialty</th>
<th>Characteristics</th>
<th>Time and Technology</th>
<th>Test/Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCT</td>
<td>RCT</td>
<td>Germany</td>
<td>traditional learning</td>
<td>5</td>
<td>Third-year</td>
<td>Dental</td>
<td>CG patients attended multiple care</td>
<td>3 weeks, 2 crisis and 2 control, study at 24-months</td>
<td>caramel water and non-caramel water, control, study at 24-months, study at 24-months</td>
</tr>
<tr>
<td>RCT</td>
<td>Germany</td>
<td>Sweden</td>
<td>traditional learning</td>
<td>5</td>
<td>Second-year</td>
<td>Dental</td>
<td>CG patients attended multiple care</td>
<td>3 weeks, 2 crisis and 2 control, study at 24-months</td>
<td>caramel water and non-caramel water, control, study at 24-months</td>
</tr>
<tr>
<td>RCT</td>
<td>UK</td>
<td>4 sessions</td>
<td>traditional learning</td>
<td>5</td>
<td>Fourth-year</td>
<td>Medicine</td>
<td>CG patients were shown virtual</td>
<td>3 weeks, 2 crisis and 2 control, study at 24-months</td>
<td>caramel water and non-caramel water, control, study at 24-months</td>
</tr>
<tr>
<td>RCT</td>
<td>Germany</td>
<td>Taiwan</td>
<td>traditional learning</td>
<td>5</td>
<td>second-year</td>
<td>Nursing</td>
<td>CG patients were shown virtual</td>
<td>3 weeks, 2 crisis and 2 control, study at 24-months</td>
<td>caramel water and non-caramel water, control, study at 24-months</td>
</tr>
<tr>
<td>RCT</td>
<td>USA</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Study ID**
<table>
<thead>
<tr>
<th>STUDY ID</th>
<th>STUDY DESIGN</th>
<th>LOCATION</th>
<th>COMPARISON</th>
<th>TOTAL NUMBER</th>
<th>YEAR OF STUDY</th>
<th>HEALTHCARE SPECIALTY</th>
<th>CHARACTERISTICS</th>
<th>TIME AND TECHNOLOGY</th>
<th>TEST OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RCCT</td>
<td>USA</td>
<td>traditional medical</td>
<td>53</td>
<td>2017</td>
<td>Medicine</td>
<td>* 5 cases</td>
<td>* audiovisuallecture on different topics</td>
<td>Knowledge, self-efficacy, satisfaction</td>
</tr>
<tr>
<td></td>
<td>RCCT</td>
<td>Australia</td>
<td>traditional medical</td>
<td>1201</td>
<td>2018</td>
<td>Medicine</td>
<td>* 5 cases</td>
<td>* audiovisuallecture on different topics</td>
<td>Knowledge, self-efficacy, satisfaction</td>
</tr>
<tr>
<td></td>
<td>RCCT</td>
<td>Germany</td>
<td>traditional medical</td>
<td>43</td>
<td>2019</td>
<td>Medicine</td>
<td>* 5 cases</td>
<td>* audiovisuallecture on different topics</td>
<td>Knowledge, self-efficacy, satisfaction</td>
</tr>
<tr>
<td></td>
<td>RCCT</td>
<td>Germany</td>
<td>traditional medical</td>
<td>36</td>
<td>2020</td>
<td>Medicine</td>
<td>* 5 cases</td>
<td>* audiovisuallecture on different topics</td>
<td>Knowledge, self-efficacy, satisfaction</td>
</tr>
<tr>
<td></td>
<td>RCCT</td>
<td>Germany</td>
<td>traditional medical</td>
<td>20</td>
<td>2021</td>
<td>Medicine</td>
<td>* 5 cases</td>
<td>* audiovisuallecture on different topics</td>
<td>Knowledge, self-efficacy, satisfaction</td>
</tr>
<tr>
<td></td>
<td>RCCT</td>
<td>Germany</td>
<td>traditional medical</td>
<td>36</td>
<td>2022</td>
<td>Medicine</td>
<td>* 5 cases</td>
<td>* audiovisuallecture on different topics</td>
<td>Knowledge, self-efficacy, satisfaction</td>
</tr>
<tr>
<td>STUDY DESIGN</td>
<td>LOCATION</td>
<td>COMPARISON</td>
<td>YEAR OF STUDY</td>
<td>HEALTHCARE SPECIALTY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>----------</td>
<td>------------</td>
<td>---------------</td>
<td>-----------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCT</td>
<td>USA</td>
<td>traditional learning vs traditional learning</td>
<td>Fourth Year</td>
<td>Medicine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCT</td>
<td>RCT</td>
<td>traditional learning vs traditional learning</td>
<td>Second Year</td>
<td>Medicine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCT</td>
<td>RCT</td>
<td>traditional learning vs traditional learning</td>
<td>Second to Fourth Year</td>
<td>Medicine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCT</td>
<td>RCT</td>
<td>traditional learning vs traditional learning</td>
<td>Third Year</td>
<td>Medicine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCT</td>
<td>RCT</td>
<td>traditional learning vs traditional learning</td>
<td>Third and Fourth Year</td>
<td>Medicine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL NUMBER**

| 5 | 6 | 8 | 2 |

**CHARACTERISTICS**

- Similar to the above table format and content but with different study designs and locations.

**TIME AND TECHNOLOGY**

- Similar to the above table format and content but with different technologies and time frames.

**TEST OUTCOMES**

- Similar to the above table format and content but with different test outcomes and technologies.

**NATURE**

- Similar to the above table format and content but with different nature and study designs.

**STUDY DESIGN**

- Similar to the above table format and content but with different study designs.

**LOCATION**

- Similar to the above table format and content but with different locations.

**COMPARISON**

- Similar to the above table format and content but with different comparisons.

**YEAR OF STUDY**

- Similar to the above table format and content but with different years of study.

**HEALTHCARE SPECIALTY**

- Similar to the above table format and content but with different healthcare specialties.
<table>
<thead>
<tr>
<th>STUDY ID</th>
<th>STUDY DESIGN</th>
<th>PARTICIPANTS</th>
<th>INTERVENTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1</td>
<td>RCT</td>
<td>USA</td>
<td>Knowledge through discussion questions that followed lectures with graphical content. Satisfaction and adherence measures included.</td>
</tr>
<tr>
<td>School 2</td>
<td>RCT</td>
<td>USA</td>
<td>Knowledge acquired through guided discussions and interactive sessions.</td>
</tr>
<tr>
<td>School 3</td>
<td>RCT</td>
<td>Jamaica</td>
<td>Knowledge acquired through guided discussions and interactive sessions.</td>
</tr>
<tr>
<td>School 4</td>
<td>RCT</td>
<td>Jamaica</td>
<td>Knowledge acquired through guided discussions and interactive sessions.</td>
</tr>
<tr>
<td>School 5</td>
<td>RCT</td>
<td>Jamaica</td>
<td>Knowledge acquired through guided discussions and interactive sessions.</td>
</tr>
<tr>
<td>School 6</td>
<td>RCT</td>
<td>Jamaica</td>
<td>Knowledge acquired through guided discussions and interactive sessions.</td>
</tr>
<tr>
<td>School 7</td>
<td>RCT</td>
<td>Jamaica</td>
<td>Knowledge acquired through guided discussions and interactive sessions.</td>
</tr>
<tr>
<td>STUDY ID</td>
<td>Methods</td>
<td>Participants</td>
<td>Intervention</td>
</tr>
<tr>
<td>----------</td>
<td>---------</td>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Transact</td>
<td>Kt</td>
<td>USA</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geologix</td>
<td>Kt</td>
<td>China</td>
<td>122</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitalink</td>
<td>Kt</td>
<td>UK</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CG: Control group
IG: Intervention group

*Publication contained two studies

### 5: Risk of bias in included studies

In this section we will cover risk of bias for the 52 included parallel RCTs studies. Risk of bias for the eight included cluster RCTs will be presented separately in a consecutive section.
Thirty-one of the studies were considered to be of low quality because of high risk of bias. [1-30] Twenty-nine of the studies [31-46] had one or more categories classified as an unclear risk of bias, especially regarding the allocation of participants to intervention groups. There was only one study [47] with all the categories classified as low risk of bias - see Figure 2 (Risk of bias graph) and Figure 3 (Risk of bias for each individual parallel RCT separately).

Figure 2. Risk of bias graph
Figure 3. Risk of bias for each individual parallel RCT separately
**Random sequence generation and allocation (selection bias)**

Most studies (25 of the 52 studies, 48%) included little or no information about the random sequence generation and were therefore classified as having an unclear risk of bias. [1, 3, 8, 11, 12, 14, 18, 19, 22-24, 30, 31, 33, 35, 38, 40, 41, 43, 44, 47-50] Only three of the 52 studies (6%) had a high risk of bias for random sequence generation. One [7] of these studies generated the allocation sequence by assigning students to an odd or even number in the order with which they were entering the room. The other two studies violated the randomization plan by letting students choose between three alternative assignments freely [6] or by assigning students to the study groups in a consecutive way, i.e. based on the order in which they undertook a specific internship.[9] The Random sequence generation was classified as judged to result in a low risk of bias for 24 [2, 5, 10, 13-16, 20, 21, 25, 27-30, 32, 36, 37, 39, 42, 45, 46, 51, 52] of the 52 studies (46%).

The method used in the majority of the cases to generate a random number sequence was computer software [5, 13-16, 21, 25, 27-30, 37, 39, 46, 51, 52]. Furthermore, one study used name drawing, [2] two studies used a random number table [20, 45] and one other used “odd” and “even” conditions from a random number series.[39]

There was no information about the allocation concealment method in 37 [1, 3, 4, 6, 8, 11-14, 16-22, 26-28, 31-36, 38-42, 44-46, 50, 53] out of the 52 trials (73%) and therefore these studies were classified as having an unclear risk of allocation bias. Five studies (10%) had high risk of allocation bias. One of these studies [2] facilitated its randomization process by drawing the name inside the class room within the presence of all class members; and another study [23] posted their randomization result on the website four days before the lecture. The other three studies [7, 9, 24] reported having problems in their randomization procedures, which made the allocation concealment impossible. Ten studies (19%) had a low risk of bias for allocation concealment. Four [25, 29, 30, 52] of these studies generated the random numbers on a computer and delivered them in a way that ensured concealment of allocation. Two studies from the same paper used the centralized randomization process.[15] The remaining four studies [10, 15, 36, 37, 42] used opaque envelopes for concealment.

**Blinding (performance bias and detection bias)**

The risk of bias assessment for blinding of participants and personnel focused only on the knowledge and skills outcomes. The risk of bias was classified as low for all but one study,[47] even though blinding of participants and personnel was not possible in any of these studies because of the nature of the intervention. The only study considered to have a high risk of bias related to blinding of participants and personnel [47] did not report any outcome on knowledge or skill. Our overall assessment for the performance bias was based on the fact that only the 43 studies investigating knowledge [2, 3, 5-12, 15-17, 20-23, 25-30, 32, 33, 35-40, 42, 44-46, 50, 53-58] and the 11 studies [1, 3, 6, 13, 14, 16, 21, 23, 32, 33, 52] measuring skills had an objective outcome assessment. Therefore, the assessment was considered impervious to the student’s opinion about the teaching method. As indicated before, subjective outcomes such as attitudes and student satisfaction were not included in the risk of bias assessment for blinding of participants and personnel. These outcomes are more prone to performance bias when participants aren’t blinded due to their subjective nature and also focusing on attitudes and student satisfaction would therefore have resulted in a high risk of bias in all studies.
Thirty-nine of the 52 included parallel RCTs (75%) were considered to be at low risk of bias for the **blinding of outcome assessment**. The risk of bias was considered low risk not only in studies where all outcome assessors were blinded [8, 14, 15, 19, 32, 42, 43, 50, 52] but also in studies with unblinded assessors as long as the method of outcome assessment included no element of interpretation and a classification of a result could be done unambiguously [2, 4, 5, 7, 9, 10, 12, 17, 18, 22, 24-29, 31, 33-36, 38-41, 45, 46, 53], e.g. the only assessment was a multiple choice test. Twelve studies (22%) were rated as having an unclear risk of bias due to the lack of information about blinding of the outcome assessors [1, 3, 6, 11, 13, 16, 20, 21, 23, 36, 37, 44]. Only one study [30] had high risk for detection bias because it reported a mixed knowledge outcome for which a part of the result was considered unblinded.

**Incomplete outcome data (attrition bias)**

As a consequence of the fact that none of the students were blinded there is a high risk of attrition bias for any outcome that relies on active participation of students for follow-up (e.g. answering a questionnaire on attitudes and satisfaction and taking a knowledge test).

A substantial number (10 out of 42, 19%) of the studies did not report complete outcome data (e.g. only reported the mean test score but did not report the number of students who were analysed) or had differential drop-out rates in the different intervention groups and were classified as high risk of bias. Two of high risk of bias studies (4%) showed a difference in the attrition/exclusion rates between the experimental groups. [1, 29] Five studies (12%) that were classified as having a high risk of bias had missing/unreported data and did not account for or comment on that. [13, 20, 23, 24, 28] The remaining three studies reported inconsistent sample sizes.[8, 22, 26] Twenty (38%) studies were classified as having a low risk of bias for incomplete outcome data. [3, 5, 6, 15-17, 27, 31-36, 40, 43, 46, 47, 50, 51] These studies reported whether attrition and exclusion had occurred. The information provided regarding the reason for not analysing all participants was either similar for the groups being compared and/or showed only a small and statistically insignificant difference between the studies.

Because details of attrition and exclusion were not reported, 22 studies (42%) were classified as having an unclear risk of bias for **incomplete outcome data** [2, 4, 7, 9-12, 14, 18, 19, 21, 25, 28, 38, 39, 41, 42, 44, 45, 52, 53]In these studies it was not clear if there was any level of attrition among the experimental groups at all.

**Selective reporting (reporting bias)**

The majority of studies (45 out of 52, 87%) were rated as having a low risk of selective reporting bias [1, 4-14, 16-23, 25, 26, 28-47, 50-52]. The assessment of selective reporting bias required the authors to report results for all outcomes mentioned in the methods sections of the published articles; protocols were not available to our reviewers. Only one study (54) (5%) was rated as having unclear risk of selective reporting bias because the authors presented more results than the outcomes mentioned in the method section. Six out of the 52 studies (12%) were rated as having a high risk of selective reporting bias. Four of these studies [2, 3, 24, 53] did not report the results in full, making it impossible to get separate results for each group. Two studies presented in the same article extended their study period to have a long-term outcome.[15]
Other potential sources of bias

Volunteer bias is an important and sometimes almost inevitable problem in studies assessing different ways of learning. Therefore, volunteer bias resulted in a high risk of bias classification in 16 of the 52 included studies (31%) [5-7, 10, 12, 14-17, 19, 23-27, 30] It was unclear whether volunteer bias was a problem in 15 of the 52 studies (29%) and therefore they were classified as having an unclear risk of bias. [3, 13, 21, 22, 28, 29, 31-33, 37, 44-46, 51, 52] Among them, nine of the studies did not provide information for the recruitment process [3, 21, 22, 31-33, 44, 45, 51], while six studies [13, 28, 29, 37, 46, 52] approached all the students but not all of them agreed to participate in the trial. Twenty studies (39%) recruited or approached entire class rooms or the entire year and were therefore at low risk of volunteer bias. [1, 2, 4, 8, 9, 11, 18, 20, 34-36, 38-43, 47, 50, 53]

We classified six more studies (12%) as having a high risk of other potential sources of bias. [1, 2, 4, 11, 13, 18, 21] Two studies suffered from imbalanced experimental groups where more material or information was given in one group compared to the other. In one study the web-based intervention group was not exposed to comparable knowledge/skills [21] as was the control group. In another study [18] the experimental groups were not provided with equivalent academic education because the students in the control group were provided only with facts that were taken from a website that is accessible to the general population. Contamination (i.e. the control group was also exposed to the eLearning intervention) was also a concern in one study (6%), which was categorised as having a high risk of bias.[11]

However, it is possible that contamination occurred in several of the other included trials as it is likely that students shared material with course mates who were randomised to a different group. Three studies were rated as having a high risk of other bias because one study used a historical control group,[1] one allowed some of the students to hand in their assessment, a schedule, in person rather than electronically,[2] while another study reported that authors had a conflict of interest with spaced education.[4]

We classified other bias as high risk of bias if one of the elements assessed was of high risk even when other elements were rated as having an unclear or low risk of bias. For example, if there was a high risk of volunteer bias but an unclear risk for using comparable learning interventions between experimental groups we would classify it as having a high risk of bias. Please refer to Figure 3 for the assessment per study.

Risk of bias in cluster RCTs

Eight studies included in our review were cluster RCTs. [54-61] In these studies one or more risk of bias items were categorised as high risk of bias. Therefore, the methods and analyses employed in these cluster RCTs were generally not judged to be of high quality.

Recruitment bias was not addressed in two [58, 59] of the eight included studies. Two other studies were assessed as high risk for recruitment bias because they applied the randomization process before recruiting the participants. [55, 56] The remaining studies [54, 57, 60, 61] that were judged to be of low risk of recruitment bias had provided sufficient information on the participant flow and randomization process.

Baseline characteristics differed between the intervention and control group in two studies. [60, 61] In three other studies there was a difference in educational level, primary care clerkships or academic grades for the previous semester at baseline. These imbalances were judged to be of high risk of affecting the outcome [55, 58] or confirmed to have modified the effect.[59] Three studies [54, 56, 57] provided no information on baseline characteristics and whether these were different between the groups.
None of the studies reported loss of entire clusters. However, three studies [55, 57, 61] reported loss of individual participants and three additional studies had a high [60] or imbalanced [58] drop-out rate or reported inconsistent numbers, [54] all of which resulted in a high-risk of bias classification. One study reported attrition in both groups but was judged as having an unclear of risk of loss of clusters for providing no further information. [59] One study [56] reported attrition but was judged to be of low risk of bias as the attrition was limited and could not have affected the results.

The data analysis of two studies [56, 60] accounted for the cluster unit. The rest of the cluster RCT studies [14, 54, 55, 57, 61, 62] suffered from unit of analysis error (i.e. incorrectly analysed participants as independent individuals rather than the unit they were randomized in). Therefore there is a high risk of false positive conclusions in these studies.

It was unclear whether or not volunteer bias had occurred in two studies. [54, 58] The remaining six studies [55-57, 59] were all categorised as having a low risk of volunteer bias.