

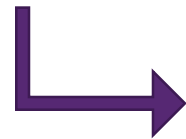
## Comparing the effectiveness of face-to-face and e-learning modules in radiation protection

# Outline

- SCK CEN Academy
- Compared training formats
- Implementation of e-learning
- Aim and method of the study
- Perception study
- Effectivity study
- Summary

# SCK CEN Academy

- SCK CEN: international player in the field of nuclear R&D
- Located: Mol, Belgium
- Mission:
  - Three major **scientific research** areas
    - Nuclear materials sciences
    - Advanced nuclear systems
    - Environment, health and safety
  - **Services** towards industry, healthcare, government
  - **Education and training**



Building of nuclear competences is key to SCK CEN  
**SCK CEN Academy**: coordinates E&T activities

# Compared training formats

Training program in radiation protection and safety  
Obligatory for new employees  
Three languages (Dutch, French, English)

## Original **face-to-face learning**

- function dependent (3 h (non-exposed) or 8 h (exposed))

## Converted to blended learning

- **E-learning** (e-l): 2-3 h, pre-quiz, 4 modules, post-quiz
- Face-to-face (ftf): function dependent (1 h or 1 h 45 min)  
SCK CEN specific content + practice



# Implementation of e-learning

- Using effective learning methods is **crucial** for high learning efficiency <sup>1,2</sup>
- Main requirement: user-centricity <sup>3</sup>



[1] E-learning and the science of instructions, R. C. Clark, R.E. Mayer, Pfeiffer (Third Edition) (2011)

[2] Does e-learning work? What the scientific research says W. Thalheimer (2017)

[3] Consultancy The Tipping Point 30/01/2017

# Implementation of e-learning

Requirements	Implementation
positive encouragement	choices (own path), progress on outline, intermediate and end quizzes, feedback

ENG\_MOD1

1.3 RADIOACTIVITY  
1.3.1 ORIGIN

Test yourself

Drag the numbers to the correct position

$^{23}_{11}\text{Na}$

The atom number

The mass number

The number of:  
Protons   
Neutrons   
Electrons

11 12 23

SUBMIT

Module 3 - Biological effects

3.1 DAMAGE PROCESSES IN THE BODY DUE TO IONISING RADIATION  
3.1.3 DNA INTERACTIONS, BREAKS AND REPAIR MECHANISMS

Click on the figure that has a double break at points not opposite one another.

SUBMIT

Why is it very difficult to separate isotopes from each other via chemical processes?

- Isotopes are heavy
- Because of equal amount of protons they have identical chemical properties
- Because of equal amount of neutrons they have identical chemical properties

SUBMIT

Result

75%

Click on feedback to go over the answers and then click on continue at the bottom of the CONNECT page.

FEEDBACK

ENG\_MOD1

1.4 SOURCES

Click on the buttons

Natural sources

Artificial sources

SUBMIT

ENG\_MOD1

1.5 TYPES OF EXPOSURE

	External	Internal
Irradiation		
Contamination		

SUBMIT

ENG\_MOD1

1.6 SHIELDING

Discover which shield can be used for each radiation type by moving the arrow.

$\alpha$

$\beta$

n

$\gamma$  X WWW

SUBMIT

ENG\_Mod4

4.3 LEGISLATION FOR NUCLEAR COMPANIES IN BELGIUM  
4.3.1 OBLIGATIONS REGARDING PROFESSIONALLY EXPOSED PERSONS

Obligations for nuclear companies

- Provide information
- Oblige personal protective equipment
- Perform dose monitoring and medical surveillance
- Protect unborn children

Click on the items.

SUBMIT

# Implementation of e-learning

Requirements	Implementation
positive encouragement	choices (own path), progress on outline, intermediate and end quizzes, feedback
relevance	include intro, separate extra info

**BASIC TRAINING**  
**RADIATION PROTECTION AND LEGISLATION**

1 Ionising radiation

2 Dosimetry

3 Biological effects

4 Legislation

The screenshot shows a video player interface. On the left, a man in a dark sweater and glasses is speaking. On the right, a list of four topics is displayed in blue text. At the bottom, there is a video control bar with a play button, a progress slider, and a refresh icon.

ENG\_Mod4

4.2 INTERNATIONAL AND NATIONAL LEGISLATION

4.2.1 INTERNATIONAL CONTEXT

Info ICRP

ICRP recommendations

Adopted by majority of countries

Targeting:

3 PILLARS FROM RADIATION PROTECTION

JUSTIFICATION ALARA LIMITS

The screenshot shows a video player interface. At the top, the course title 'ENG\_Mod4' is visible. Below it, the current slide title '4.2 INTERNATIONAL AND NATIONAL LEGISLATION' and sub-title '4.2.1 INTERNATIONAL CONTEXT' are shown. A button labeled 'Info ICRP' is on the right. The main content area contains text about ICRP recommendations and a diagram titled '3 PILLARS FROM RADIATION PROTECTION'. The diagram shows three pillars: 'JUSTIFICATION' (scales of justice), 'ALARA' (gauge), and 'LIMITS' (gavel). A man in a dark sweater and glasses is speaking on the right side of the slide. At the bottom, there is a video control bar with a play button, a progress slider, and navigation buttons for 'PREV' and 'NEXT'.

# Implementation of e-learning

Requirements	Implementation
positive encouragement	choices (own path), progress on outline, intermediate and end quizzes, feedback
relevance	include intro, separate extra info
recognizability, build upon back ground	fixed order

↪	Introduction and <b>pre-quiz</b>
↪	Ionising radiation
↪	Dosimetry
↪	Biological effects
↪	Legislation
↪	<b>Post-quiz</b>



# Implementation of e-learning

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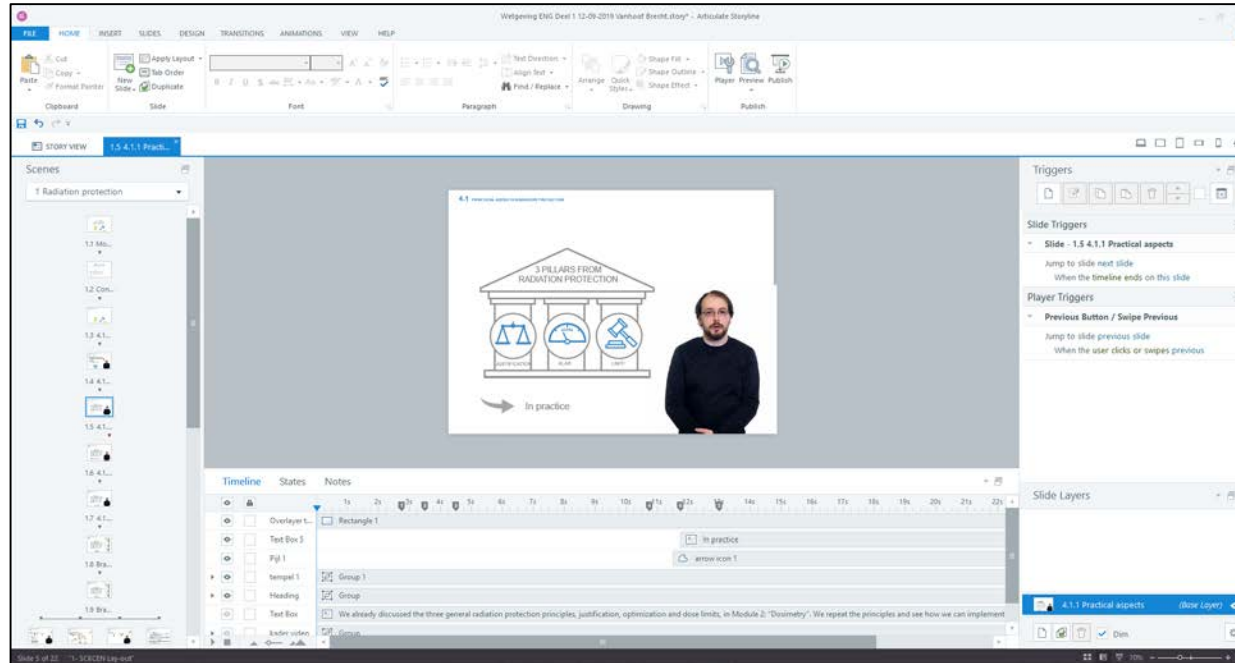
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limited attention span	30-45 min, shortened training

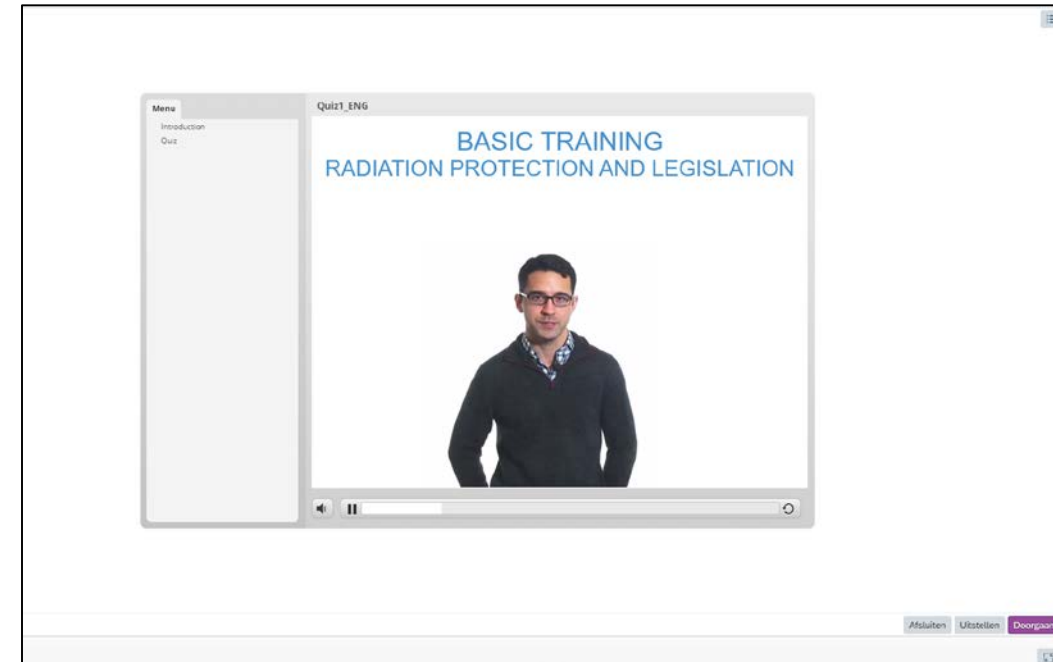


# Implementation of e-learning

E-learning software:  
Storyline (SCORM compliant)

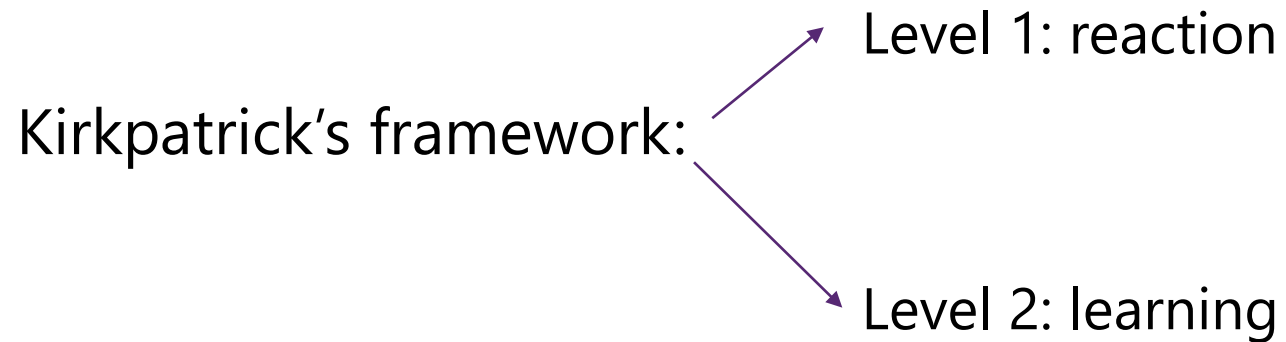


Learning Management System:  
SAP Success Factors



# Aim of the study

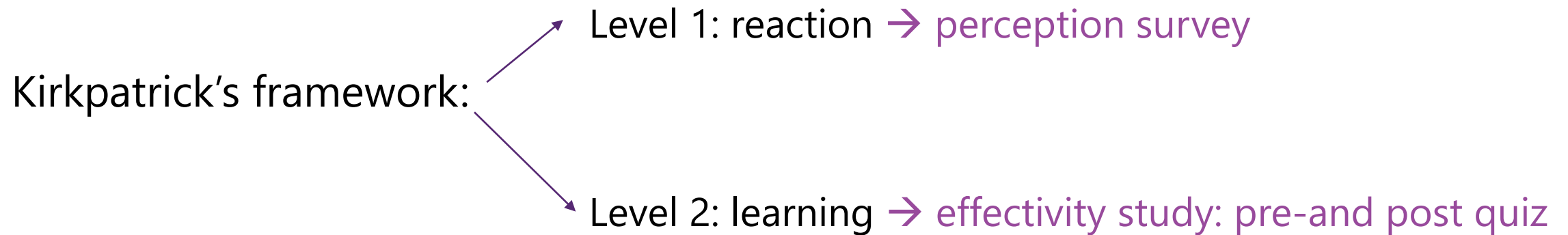
1. Evaluate the **e-learning** on radiation protection and safety



2. Compare with the original **face-to-face** training

# Method of the study

## 1. Evaluate the **e-learning** on radiation protection and safety



## 2. Compare with the original **face-to-face** training → pre-and post quiz

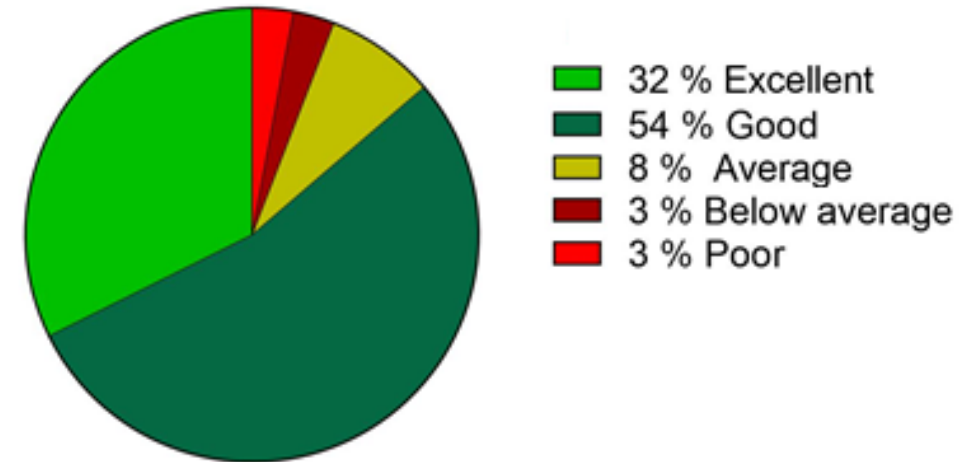
Note: Difficult to compare literature studies: details of learning methods are not always provided

# Results perception study

- Feedback of 40 trainees on online survey
- Feedback/suggestions depended on background of learners

# Results perception study

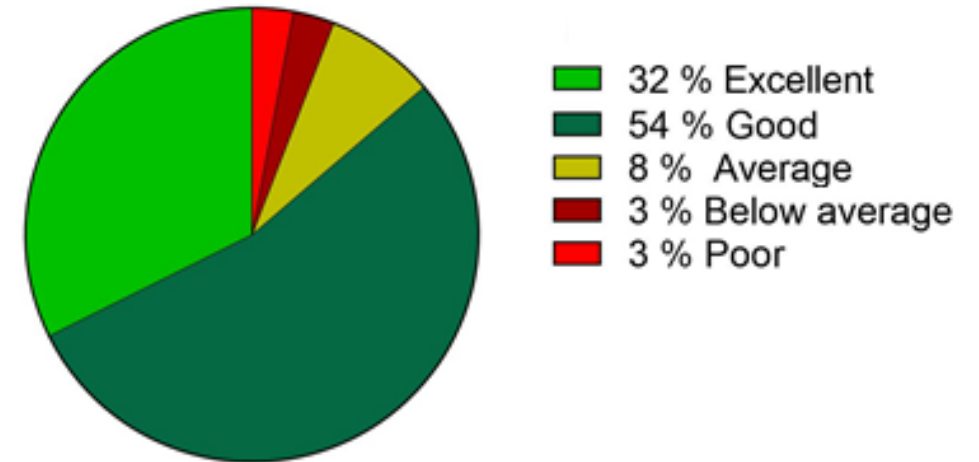
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- 86 % rated the e-l as **good or excellent**





## Results perception study

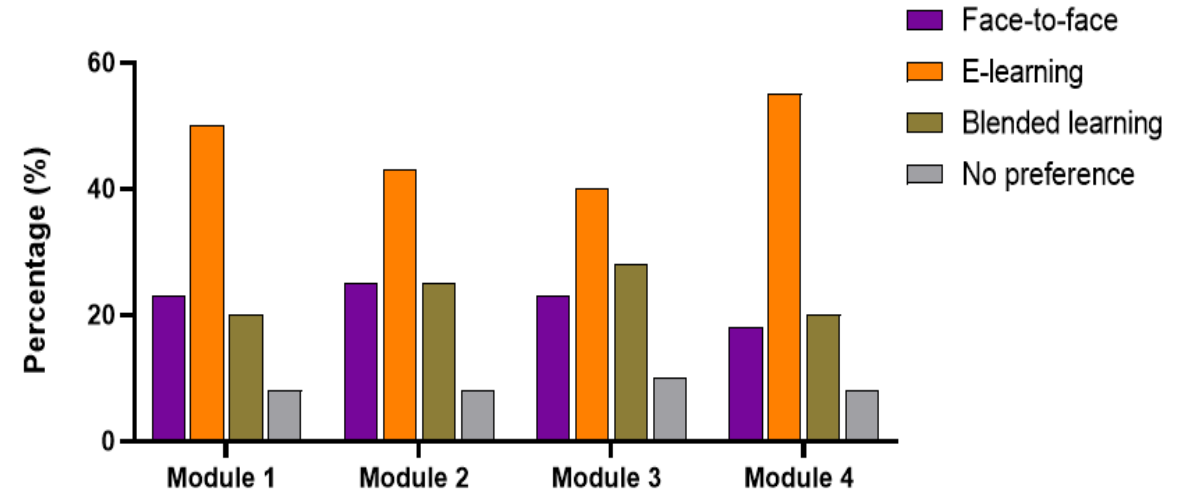
- Feedback of 40 trainees on online survey
- Feedback/suggestions depended on background of learners
- 86 % rated the e-l as **good or excellent**



- > 1/3 rated the e-l as extremely or slightly **more effective** compared to ftf

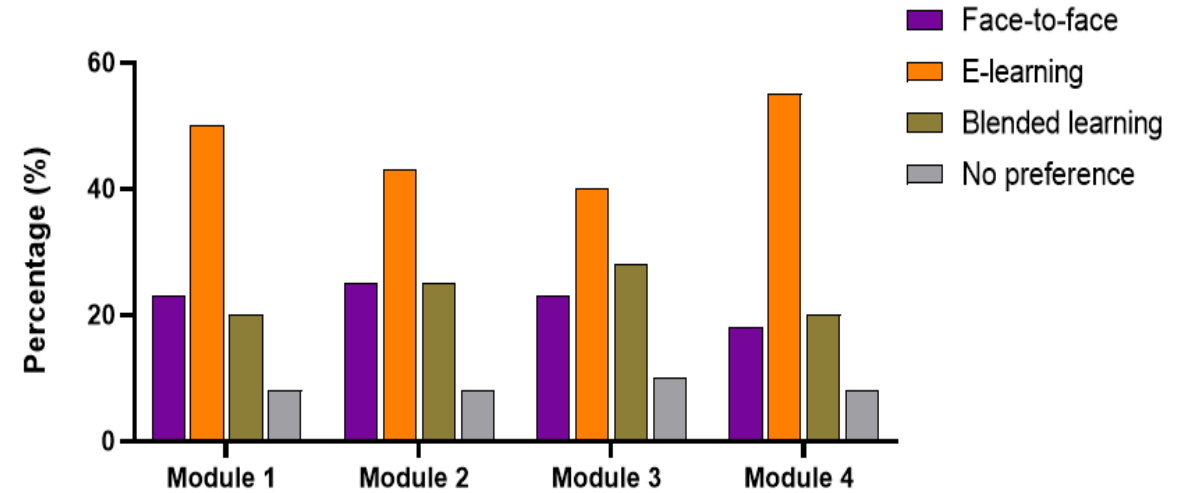
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- E-l is **preferred format** (40-55 %)
  - 👍 -> *flexible + own speed*
  - 👎 -> *no contact (teacher, trainees)*



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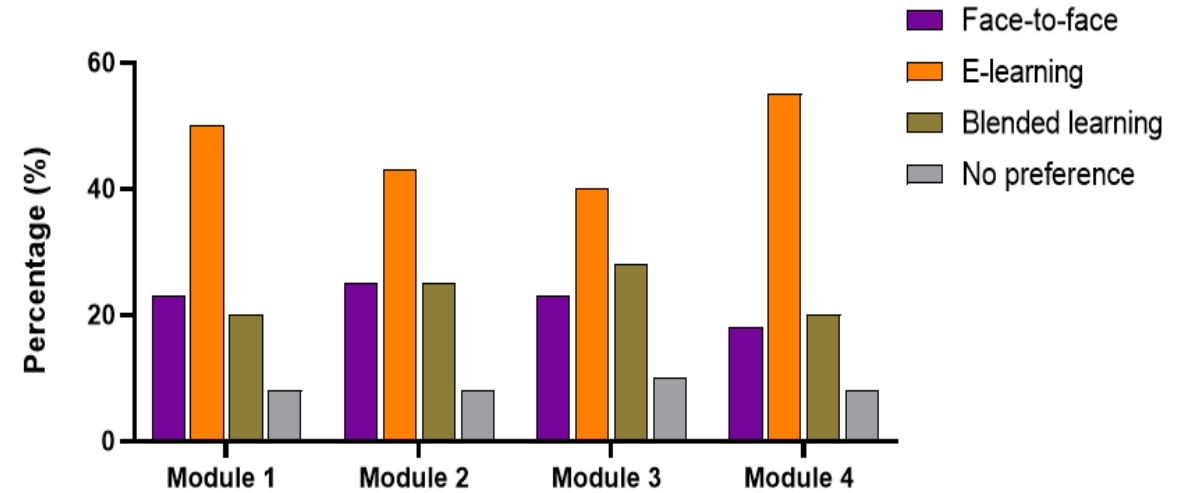
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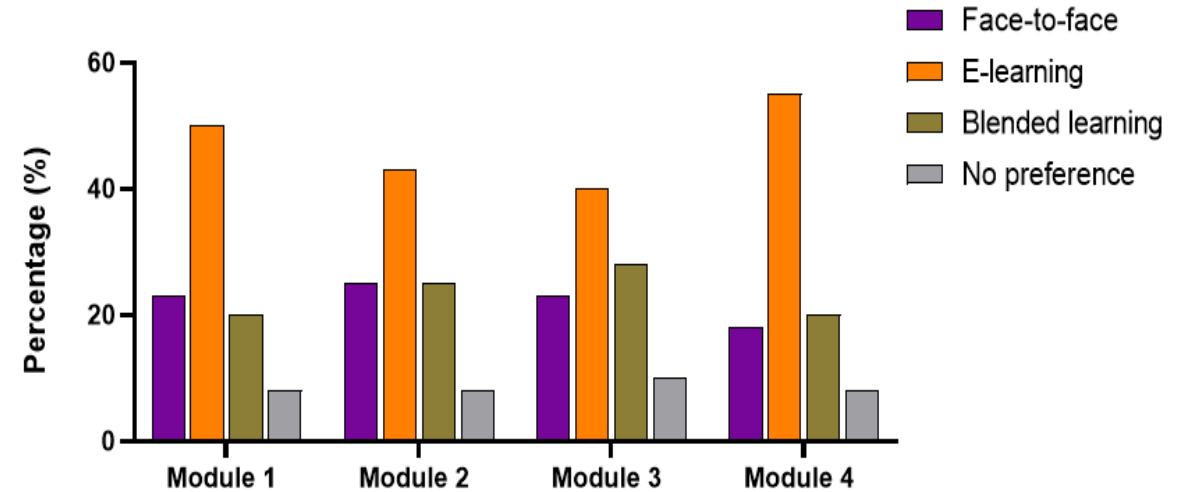


-> *no contact (teacher, trainees)*

- **Duration** of 30-45 min was appropriate

- Laptop, desktop preferred **devices**

- 55 % would **revisit** the e-l (yes: refreshment, no: online search is faster)

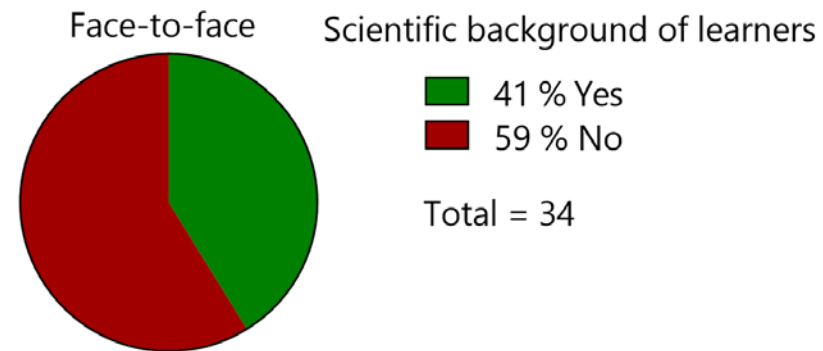
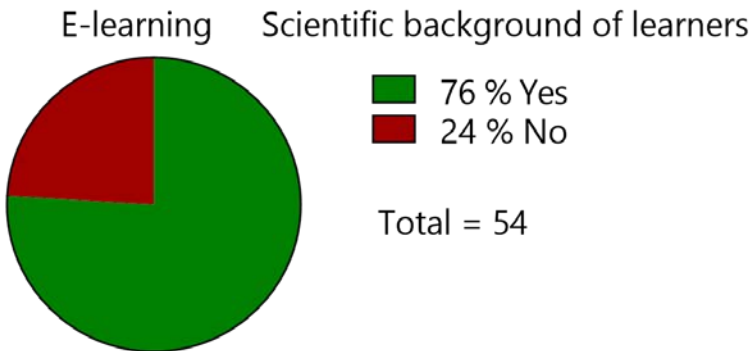


## Results effectivity study

- Identical pre and after questionnaire of 10 questions
- Different questions for Dutch, English and French session

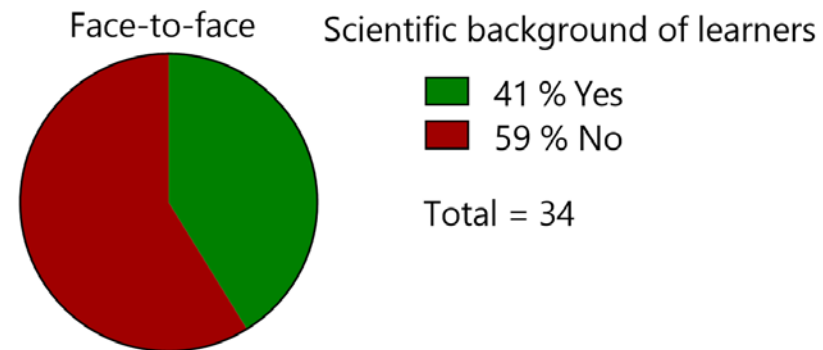
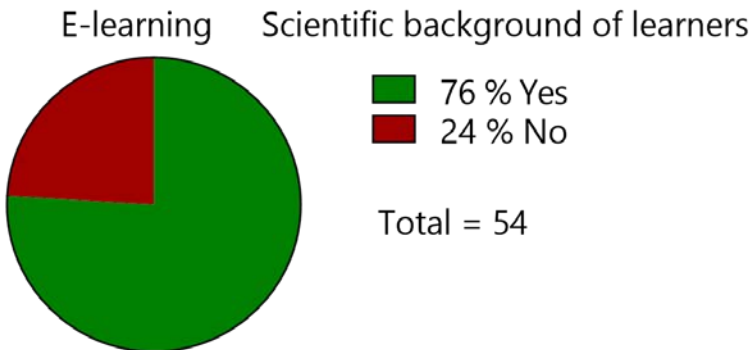
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- Total answers: e-l 54, ftf 34, difference in background of learners



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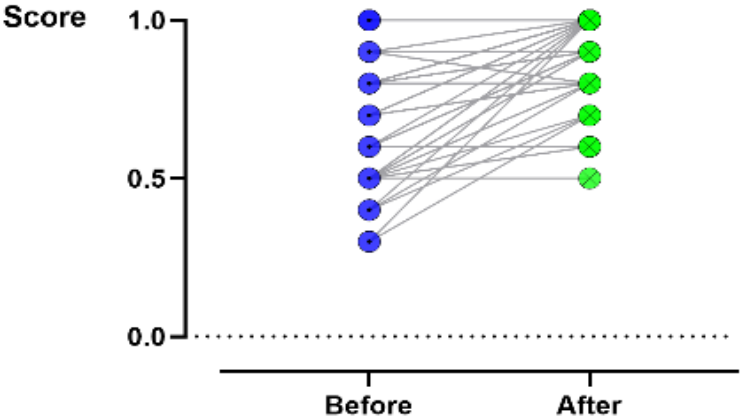
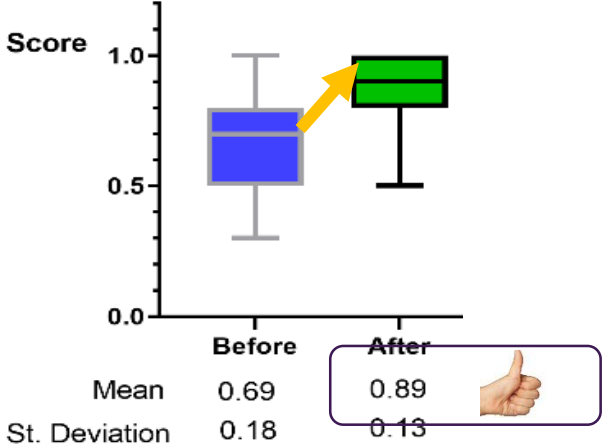
- Analysis of significance (Wilcoxon matched-pairs test, Paired t-test) and normality (Anderson-Darling test)



# Results effectivity study

## E-learning

N= 54, P< 0.0001





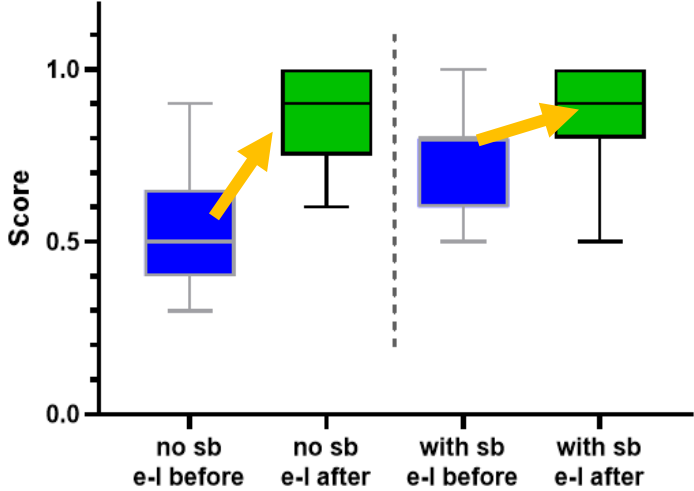
# Results effectivity study – learners background



## E-learning

No/ with scientific background N= 13/41

P < 0.05



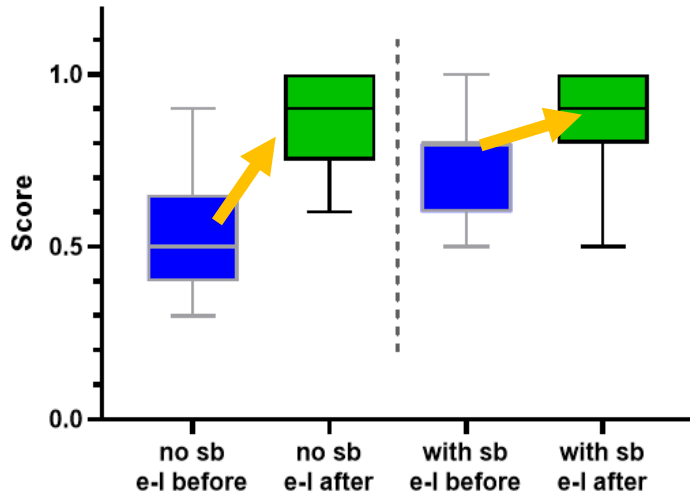
	no sb e-l before	no sb e-l after	with sb e-l before	with sb e-l after
Mean	0.53	0.86	0.74	0.90
Std. Deviation	0.18	0.14	0.15	0.13

# Results effectivity study – learners background



## E-learning

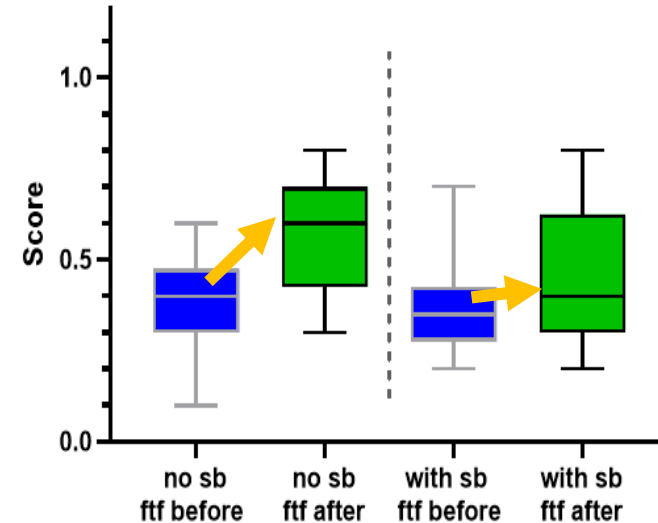
No/ with scientific background N= 13/41  
 $P < 0.05$



Mean	0.53	0.86	0.74	0.90
Std. Deviation	0.18	0.14	0.15	0.13

## Face-to-face training

No/ with scientific background N= 20/14  
 $P < 0.05$



Mean	0.37	0.57	0.37	0.47
Std. Deviation	0.13	0.15	0.15	0.21

Largest gain: - for group having no scientific background  
 - in e-learning

# Summary

- Study on **learning formats** of the 'Radiation protection and safety training' for new SCK CEN employees
- Two learning formats, same content: e-learning and face-to-face training
- Kirkpatrick (1) evaluation on **reaction** (survey) and (2) **learning** (pre/post test)

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- Study on **learning formats** of the 'Radiation protection and safety training' for new SCK CEN employees
  - Two learning formats, same content: e-learning and face-to-face training
  - Kirkpatrick (1) evaluation on reaction (survey) and (2) learning (pre/post test)
  
  - **Reaction**: e-l well received due to flexibility and design
  - **Learning**: knowledge gain in both formats
- Highest:
- for e-l format → high efficiency instructional design is key
  - for employees without scientific background  
→ e-learning would allow personal learning paths

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Highest:

- for e-l format → high efficiency instructional design is key
- for employees without scientific background  
→ e-learning would allow personal learning paths

→ Reaction and learning confirms use of e-l

Classroom training remains important

- Skills
- Attitudes

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### **SCK CEN**

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