# PERSONALIZED MILITARY TRAINING, SUPPORTED BY LEARNING ANALYTICS

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TNO innovation for life

# MILITARY EDUCATION & INDIVIDUAL TRAINING

## RESEARCH PROGRAM MINISTRY OF DEFENSE NL (2017 – 2021)

**Main research question:**

- *"What methods for designing education and individual training will enable a flexible adaptation to today's dynamically changing operational context"?*

**ADAPTIVE MILITARY**

# RESEARCH TOPICS: FLEXIBILISATION

**Learning environment:**
- Next generation learning
- Adaptive coaching
- Flexible curricula

**Individual learning processes:**
- Informal learning
- Personalized learning
- Learning analytics
- Retention

**Future scenarios 2030**

**Design:**
- Short and cyclic design processes

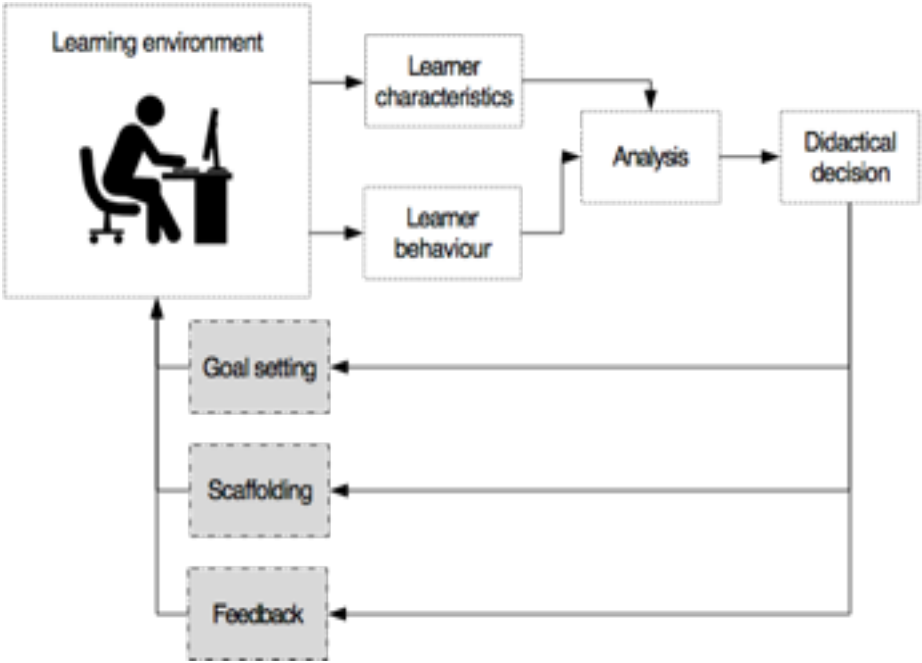
# PERSONALIZED LEARNING

## Definition

- “Adapting the selection, presentation, structure, and combination of the learning content and method to the behavior, characteristics and responses of an individual learner” (Durlach & Spain, 2014; Oxman & Wong, 2014)

## Three main strategies for personalization:

- Goal setting: aligning learning content to the learner
- Scaffolding: successive levels of temporary support
- Feedback: information on learning and performance




Van den Bosch et al., 2017

# LEARNING ANALYTICS

## Definition

- “Measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs” (Ferguson, 2012)

## Two main goals for military training:

- Personalized learning: adapt training (content, method) to individuals based on a personal learner profile
- Training evaluation: adapt design of training based on data collected within groups of learners


*Example of a learning analytics dashboard*

# STUDY 1: PERSONALIZED FEEDBACK IN GAMING

## Objective of the game

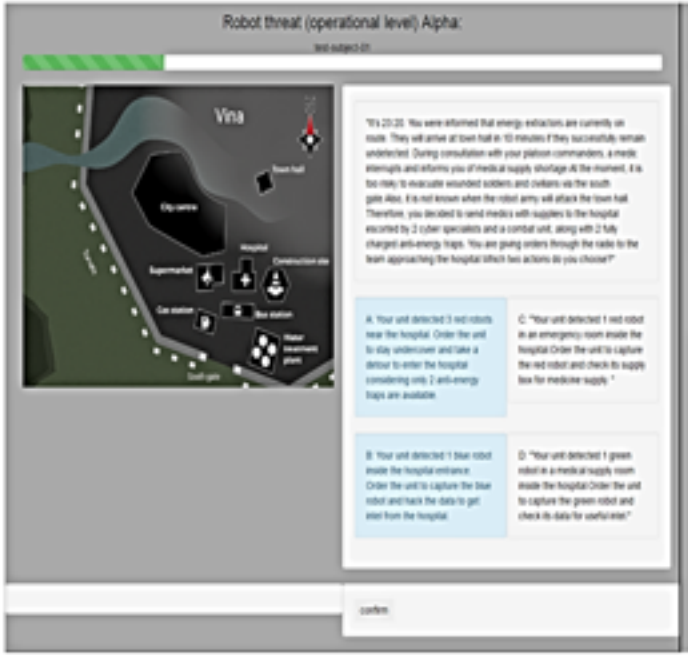
- Improve *adaptability*

## Scenario's in the game

- Choose preferred actions
- Get feedback on the effects

## Manipulation: *rule change*

- Detect & unlearn old rules
- Learn & apply new rules




1.Choosing actions (indicated as blue)


2. Receiving feedback (on the right panels next to selected options)

# PERSONALIZED FEEDBACK

**Game play (scenario 0)**

**Shadowbox* assignment**

***Determine a learners' profile***

**Control group:**
*Standardized feedback*

**Experimental group:**
*Personalized feedback*

**Game play (scenario 1-3)**

**Personal learning profile**

***Motivational feedback***

**P1:** Not detecting change

***Elaborated feedback***

**P3:** Adaptive learner

**P2**: Not readjusting strategy

***Process feedback***

**Prioritize four options, followed by a subject matter expert's answer in order to stimulate reflection for learning purposes (Klein, Hintze & Saab, 2013).*

# RESEARCH DESIGN

| Condition | Scenario's | | | |
|---|---|---|---|---|
| | Baseline *(feedback)* | Learning *(feedback)* | Learning *(feedback)* | Test *(no feedback)* |
| Standardized | S0 | S1 | S2 | S3 |
| Personalized | S0 *(determine profile)* | S1 *(adjust profile)* | S2 *(adjust profile)* | S3 |

***Performance measures; questionnaires (4x)***

| **Participants per condition** | Female | Male | Age (*m*) | **Total** |
|---|---|---|---|---|
| Standardized | 8 | 15 | 21.7 | **23** |
| Personalized | 8 | 15 | 21.4 | **23** |

# MEASURES

**RMSE**

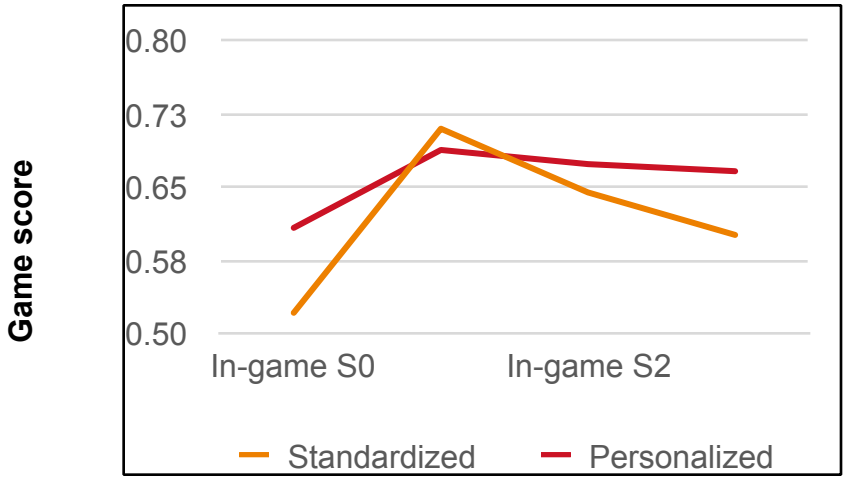

**Performance measures:**

- In-game scores (logdata)
- Shadowbox assignment scores

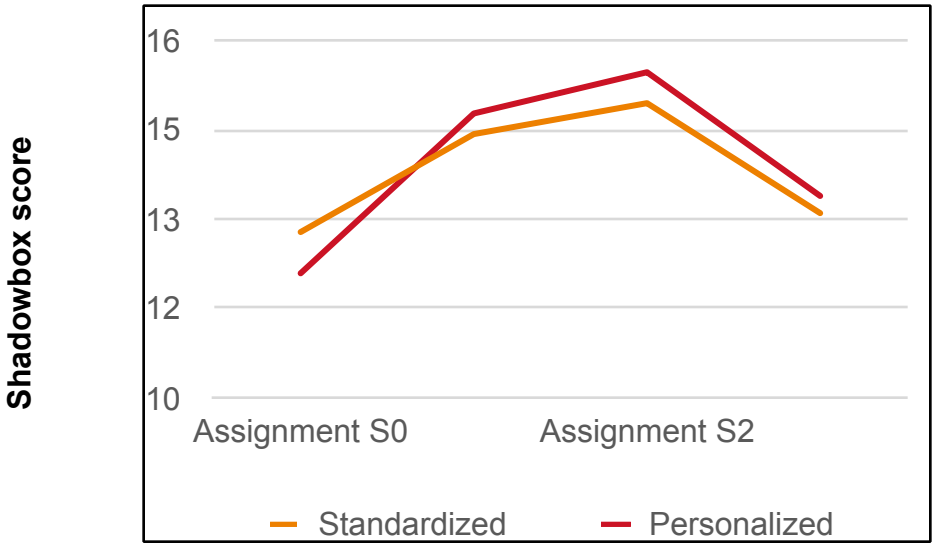
**Questionnaires:**

- Intrinsic Motivation Inventory (IMI; Ryan, 1982), rated at 7 points scale :
  - Interest/enjoyment (IE; 7 items;), e.g. *"I enjoyed doing this activity very much"*
  - Perceived competence (PC; 6 items) e.g. *"After working on this activity for a while, I felt pretty competent".*
- Rating Scale Mental Effort (RSME; Zijlstra, 1993): see picture

# RESULTS: REPEATED MEASURES ANOVA (1)

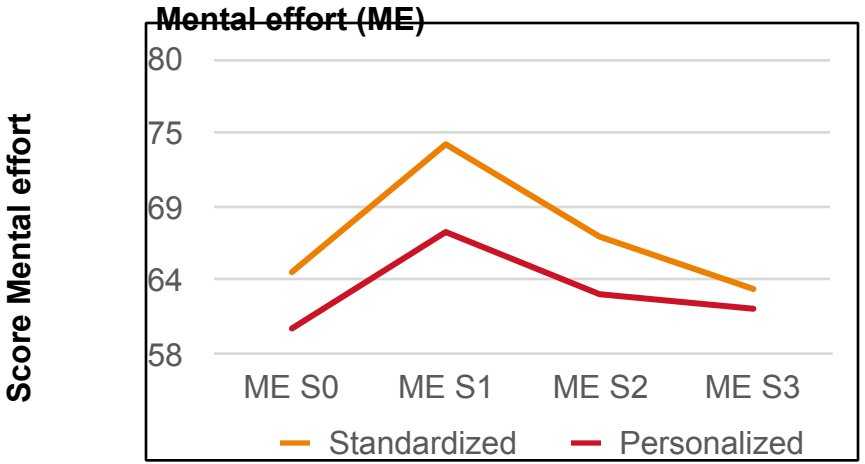



*No sign results for between-subjects or interaction effects;*
*Within-subjects (scenario): F(2.46, 105.78) = 5.65, p <.01*

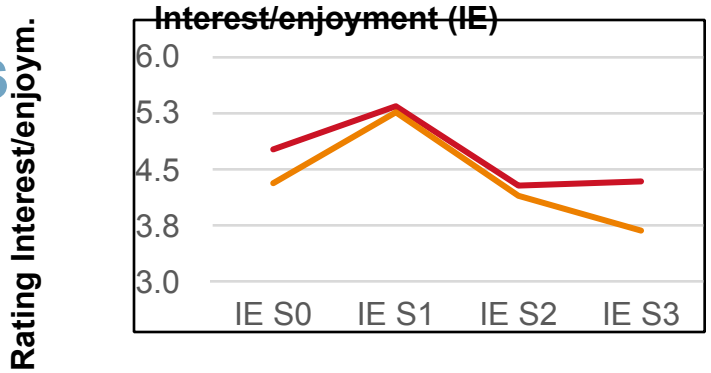



*No sign results for between-subjects or interaction effects;*
*Within subjects (scenario): F(1.68, 74.03) = 29.41, p < .001*

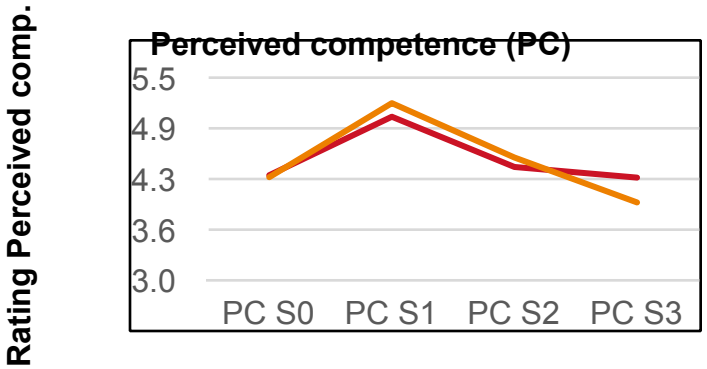
# RESULTS: REPEATED MEASURES ANOVA (2)




*No sign results for between-subjects or interaction effects;*
*Within-subjects (scenario): F(3.62,159.31) = 6.08, p <.001*




*No sign results for between-subjects or interaction effects;*
*Within subjects (scenario): F(3, 129) = 14.45, p <.001*




*No sign results for between-subjects or interaction effects;*
*Within subjects (scenario): F(3, 129) = 11.42, p <.001*

# CONCLUSIONS

**Personalized feedback:**

- Suggests to result in slightly higher performance (but not significant!)
- Suggests to result in higher interest & perceived competence, lower mental effort (but not significant!)

**Learning effects:**

- Highest learning effect from scenario 0 (baseline) to scenario 1
- Lowest performance in baseline (unfamiliarity) and test scenario (no feedback, boredom, difficulty)

**Conclusion:**

- Personalized learning seems to make learning more effective

# STUDY 2: LEARNING ANALYTICS

**TACTIS simulator: shooter CV-90**

- 19 lessons divided over 3 weeks
- First sample: N = 17 + 16 military students (2 groups)

**Preliminary study**

- Insight into data analyses techniques (*data mining,* etc)
- Relationships between log data, instructor's ratings and self-ratings (self-assessment, motivational characteristics)

**Ultimate goal:**

- Developing a learning analytics application for personalized lea…..g

# LOGDATA

- Screenshot of preliminary data set: student's actions, feedback messages, scores
- In total (for 1 lesson, 1 student): **2328** columns (= variables) with data

| TnoId | Lesson_Code | Lesson_ExecutionDate | Lesson_LessonStepCount | LessonStep_LessonStepId_4 | LessonStepExport_4_0_RepeatNr_0 | LessonStepExecution_4_0_LessonStepExecutionId | LessonStep_4_0_Description | LessonStepExecution_4_0_StartTime | LessonStepExecution_4_0_EndTime | LessonStepExecution_4_0_MessageCount | LessonStepError_4_0_ErrorTypeId_1 | LessonStepError_4_0_UniqueIdentification_1 | LessonStepError_4_0_Message_1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CALesson_20( | 25-05-2018 10:29:48 | 31 | 4 | 0 | 4 | 04 Tekst: Actie | 203 | 214 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 1 | CALesson_20( | 16-05-2018 08:54:33 | 36 | 4 | 0 | 4 | 04 Tekst: Actie | 212 | 226 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 2 | CALesson_20( | 25-05-2018 10:29:55 | 26 | 4 | 0 | 4 | 04 Tekst: Actie | 302 | 313 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 2 | CALesson_20( | 16-05-2018 09:27:33 | 31 | 4 | 0 | 4 | 04 Tekst: Actie | 366 | 378 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 3 | CALesson_20( | 17-05-2018 13:02:47 | 29 | 4 | 0 | 4 | 04 Tekst: Actie | 407 | 428 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 4 | CALesson_20( | 16-05-2018 08:54:33 | 25 | 4 | 0 | 4 | 04 Tekst: Actie | 246 | 257 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 4 | CALesson_20( | 25-05-2018 10:29:48 | 22 | 4 | 0 | 4 | 04 Tekst: Actie | 434 | 445 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 5 | CALesson_20( | 16-05-2018 09:27:34 | 32 | 4 | 0 | 4 | 04 Tekst: Actie | 571 | 587 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 5 | CALesson_20( | 25-05-2018 10:29:55 | 19 | 4 | 0 | 4 | 04 Tekst: Actie | 435 | 450 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 6 | CALesson_20( | 25-05-2018 10:29:55 | 22 | 4 | 0 | 4 | 04 Tekst: Actie | 255 | 265 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 6 | CALesson_20( | 16-05-2018 09:27:33 | 27 | 4 | 0 | 4 | 04 Tekst: Actie | 335 | 350 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 7 | CALesson_20( | 25-05-2018 10:29:55 | 22 | 4 | 0 | 4 | 04 Tekst: Actie | 324 | 342 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 7 | CALesson_20( | 16-05-2018 09:27:33 | 26 | 4 | 0 | 4 | 04 Tekst: Actie | 471 | 487 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 8 | CALesson_20( | 25-05-2018 10:29:48 | 27 | 4 | 0 | 4 | 04 Tekst: Actie | 236 | 252 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 8 | CALesson_20( | 16-05-2018 08:54:33 | 31 | 4 | 0 | 4 | 04 Tekst: Actie | 218 | 247 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 9 | CALesson_20( | 17-05-2018 13:02:47 | 24 | 4 | 0 | 4 | 04 Tekst: Actie | 418 | 428 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 10 | CALesson_20( | 17-05-2018 13:02:47 | 33 | 4 | 0 | 4 | 04 Tekst: Actie | 295 | 352 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 11 | CALesson_20( | 17-05-2018 12:49:30 | 30 | 4 | 0 | 4 | 04 Tekst: Actie | 1130 | 1158 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 12 | CALesson_20( | 17-05-2018 12:49:30 | 27 | 4 | 0 | 4 | 04 Tekst: Actie | 1183 | 1194 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 13 | CALesson_20( | 17-05-2018 12:49:30 | 22 | 4 | 0 | 4 | 04 Tekst: Actie | 1136 | 1148 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 14 | CALesson_20( | 17-05-2018 12:49:30 | 34 | 4 | 0 | 4 | 04 Tekst: Actie | 1169 | 1187 | 1 | 6 | G414 | Start |
| 15 | CALesson_20( | 17-05-2018 13:02:47 | 43 | 4 | 0 | 4 | 04 Tekst: Actie | 275 | 287 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 16 | CALesson_20( | 25-05-2018 10:29:48 | 26 | 4 | 0 | 4 | 04 Tekst: Actie | 288 | 307 | 1 | 6 | G414 | Start |
| 16 | CALesson_20( | 16-05-2018 08:54:33 | 32 | 4 | 0 | 4 | 04 Tekst: Actie | 304 | 377 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |
| 17 | CALesson_20( | 17-05-2018 13:02:47 | 27 | 4 | 0 | 4 | 04 Tekst: Actie | 289 | 303 | 3 | 1 | ARM_SCHAKELAAR_5 | Zet ARM SCHA |

# MEASURES

## BEFORE (only group 1)

**Performance**
- Self-assessment
- Instructor's assessment

**Learning features** (MSLQ; Pintrich & De Groot, 1990)
- Self-efficacy
- Motivation
- Fear of failure

## LEARNING

**Performance**
- Self-assessment
- Instructor's assessment

**Mental effort (NASA TLX),** *after each lesson*

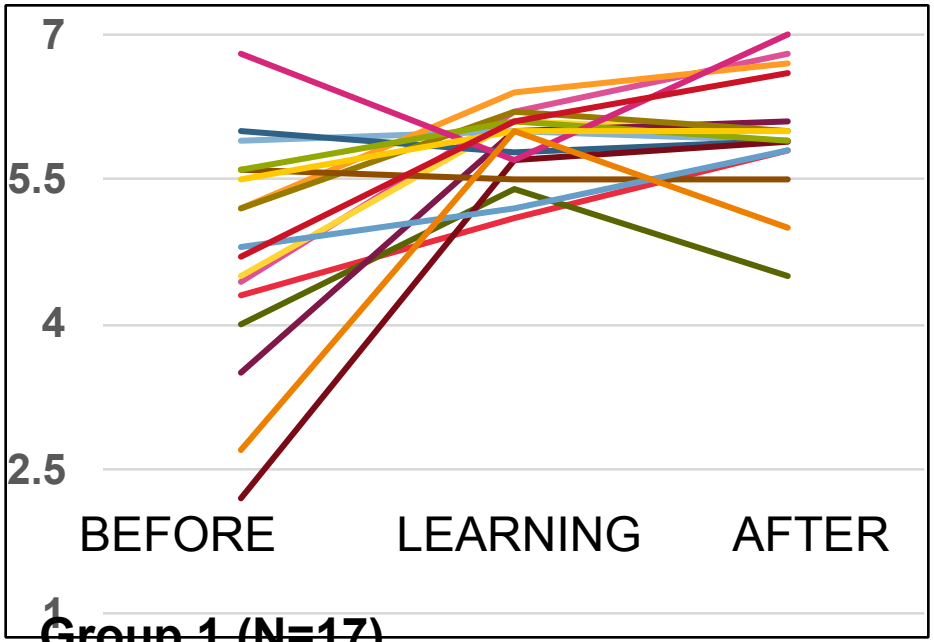
**Log data**
***(not available yet)***

## AFTER

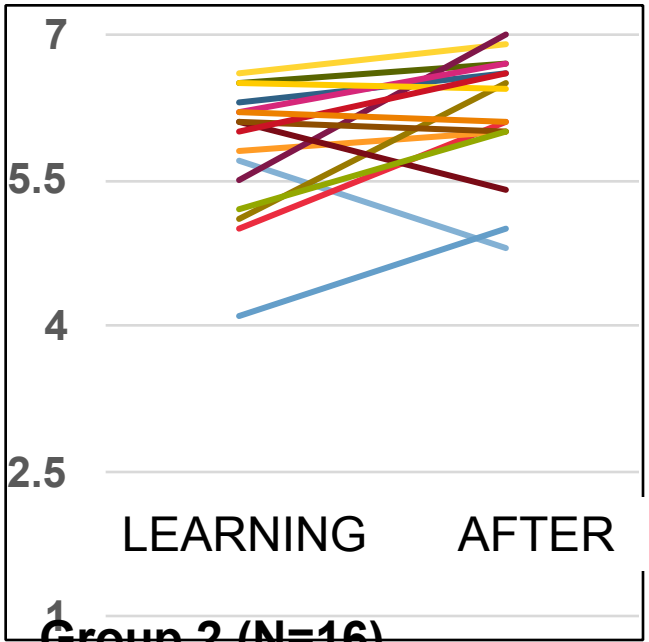
**Performance**
- Self-assessment
- Instructor's assessment

**Learning features (IMI):**
- Interest/enjoyment
- Perceived competence
- Effort/importance
- Pressure/tension
- Value/usefulness

# PRELIMINARY RESULTS: SELF-ASSESSMENTS




Group 1 (N=17)




Group 2 (N=16)

# CORRELATIONS: SELF-ASSESSMENTS

| **MSLQ/ NASA TLX** | Self-efficacy | Motivation | Fear of failure | Mental effort |
|---|---|---|---|---|
| *Before (N=17)* | .44 | .18 | .18 | -.28 |
| *Learning (N=33)* | .26 | .35* | .07 | -.13 |
| *After (N=33)* | .08 | .08 | .16 | -.13 |

| **IMI** | Interest/ enjoyment | Perceived comp. | Effort/ importance | Pressure/ tension | Value/ usefulness |
|---|---|---|---|---|---|
| *Before (N=17)* | -.52* | -.03 | -.42 | -.14 | -.58* |
| *Learning (N=33)* | -.10 | .24 | -.09 | -.08 | -.09 |
| *After (N=33)* | .06 | .54** | -.06 | -.35* | .03 |

***. Correlation is significant at the 0.01 level (2-tailed).*

**. Correlation is significant at the 0.05 level (2-tailed).*

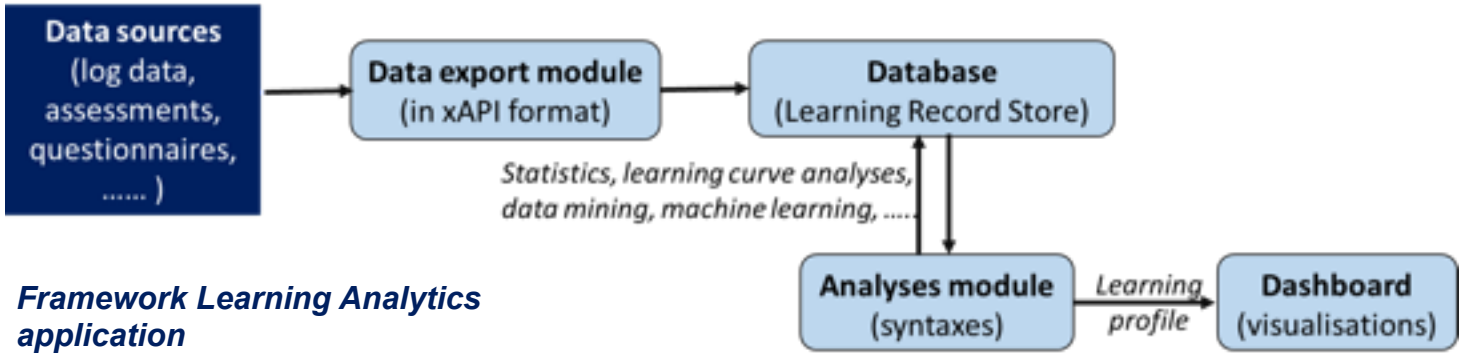
# CONCLUSIONS & FUTURE STEPS

**Preliminary conclusions self-assessment:**

- Trainees with high self-assessed performance find the training less interesting and less valuable
- 'Perceived competence' and 'lack of pressure' relates to self-assessed performance at the end of training
- Variability between trainees on self-assessed performance differs more before than at the end of training

**Future steps**

- Include logdata
- Build LA application




***Framework Learning Analytics application***