The Digitization of Work: VET adults' problem-solving skills in technology-rich environments

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What the increasingly technological society means for learning and professional development?

How technology can be harnessed to enhance learning of various new skills and competences?

Grounding challenges

- Problem-solving skills in (TRE) are among the critical competencies to be mastered
- Structural change: mass-production > flexible production methods
- In Finland: more than 100,000 jobs have disappeared from the industrial sector
- The changing needs of working life create new challenges for vocational competences
- Needs for developing vocational skills and professional expertise
  - Handling and producing new information
  - Solving problems in TRE

Skills?

Small experiments

Critical: No large-scale assessment data

PIAAC - Data

- A large-scale programme for monitoring performance in literacy, numeracy and technology-rich problem-solving in TRE among adults in 24 countries
  - A large background questionnaire
  - A computer-based test

Definition of PS-TRE in PIAAC

"Problem solving in technology-rich environments involves using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks. The first PIAAC problem solving survey focused on the abilities to solve problems for personal, work and civic purposes by setting up appropriate goals and plans, accessing and making use of information through computers and computer networks". (OECD, 2012, p. 47)

Tabel 2.2 Vaardigheidsniveau: probleemoplossen in technologierijke omgevingen.

Niveau	Interval	Probleemoplossen
Onder niveau 1	< 241	De t… funct… crite… gebru… tusse…
1	241-290	Taken op dit niveau veronderstellen het gebruik van vertrouwde technologische applicaties zoals e-mail software en internet browsers. Er is weinig of geen navigatie van de applicatie vereist om de informatie te vinden of om het probleem te kunnen oplos… niet … aanta… het … probl… (bijv… Het … overeenkomsten. Alleen eenvoudige redeneringen (bijv. het toewijzen van items aan categorieën) zijn vereist. Het is niet noodzakelijk om informatie te contrasteren of integreren.
2	291-340	Bij taken op dit niveau dient men algemene en meer gespecialiseerde technologische applicaties te gebruiken (bijv. het gebruik van een nieuw online formulier). Enige navig… (bijv… het d… gede… besch… of im… relevantie van informatie om afleiders te kunnen schrappen. Enige integratie van informatie is vereist.
3	> 340	Bij taken op dit niveau dient men algemene en meer gespecialiseerde technologische applicaties te gebruiken. Enige navigatie doorheen de pagina's of applicaties is nood… oplos… stapp… de re… opvo… waar… relevantie en betrouwbaarheid van informatie om afleiders te kunnen schrappen. Er wordt soms in grote mate beroep gedaan op het integreren van informatie en op deductief redeneervermogen.

<1 < 241 At risk

1 241 - Weak

49

2 291 - Moderate

3 > 340 Strong

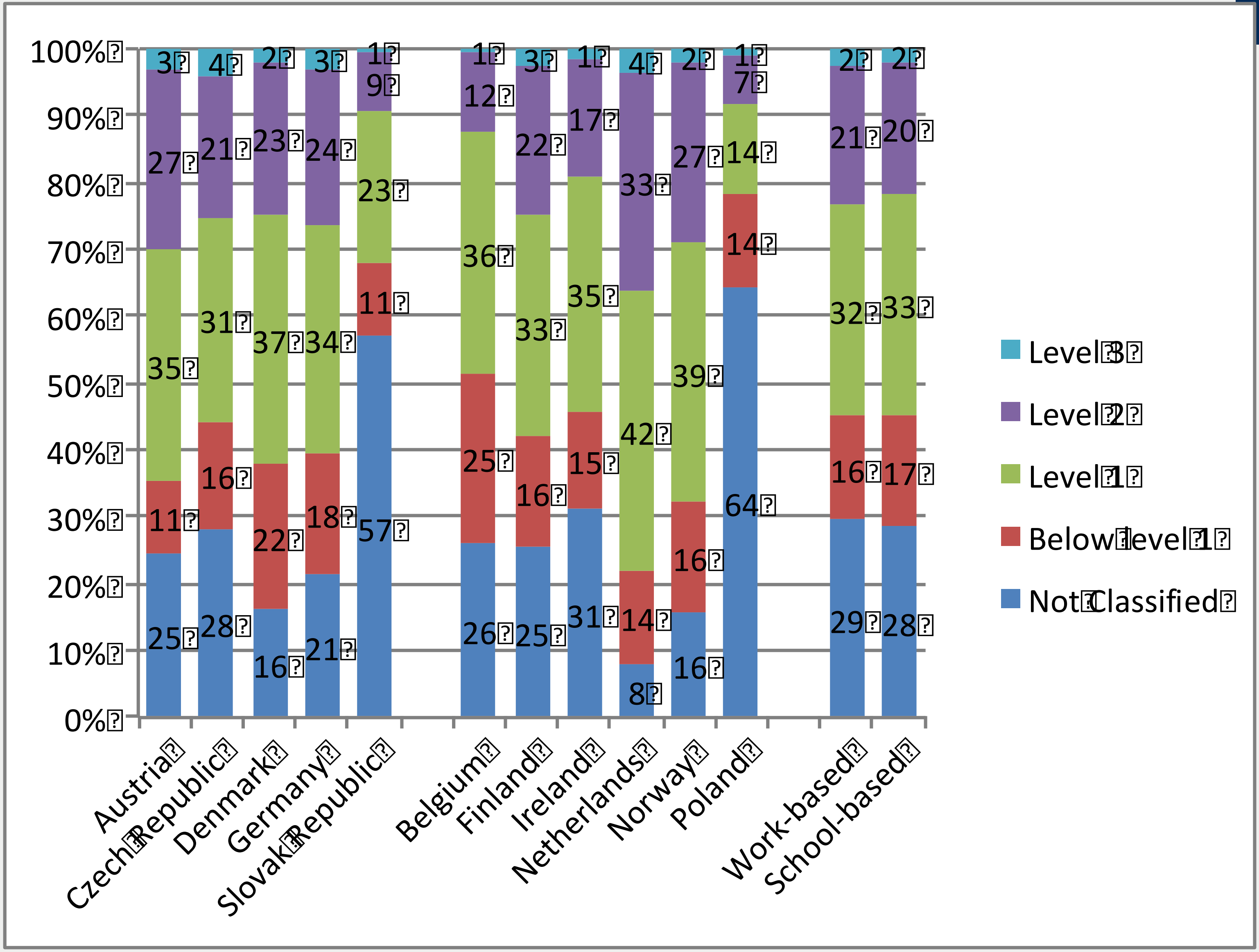
VET European level	Hämäläinen, R., Cincinnato, S., Malin, A. & De Wever, B. (2014). VET workers' problem-solving skills in technology-rich environments: European approach. *International Journal for Research in Vocational Education and Training,* 1(1), 57-80.
The factors explaining the variation in problem-solving in TRE (Finland)	Hämäläinen, R., De Wever, B., Malin, A. & Cincinnato, S. (2015). Education and working life: VET adults' problem-solving skills in technology-rich environments*. Computers & Education, 88*, 38-47.
Understanding vet adults' strong problem-solving skills	•Hämäläinen, R., De Wever, B., Nissinen, K. & Cincinnato, S. (2017). Understanding adults' strong problem-solving skills based on PIAAC. *Journal of Workplace Learning*. *29*(7/8), 537-553.
HE adults´ problem-solving skills in Europe	Hämäläinen, R., De Wever, B., Nissinen, K., & Cincinnato, S. (2019). What makes the difference - PIAAC as a resource for understanding the problem-solving skills of Europe's higher-education adults. *Computers & Education*. 129. 27-36.
Teachers´ problem-solving skills	De Wever, B., Hämäläinen, R., Nissinen, K., Mannonen, J. & Van Nieuwenhove, L. (2019). Teaching professionals' problem-solving skills in TRE based on PIAAC
Problem-Solving in TRE: Formal, Non-Formal, and Informal Learning	•Nygren, H., Nissinen, K., Hämäläinen, R. & De Wever, B., (2019, accepted for publication). Lifelong Learning: Formal, Non-Formal, and Informal Learning in the Context of Problem-Solving Skills in Technology-Rich Environments. *The British Journal of Educational Technology*.

Aim I: European level

- What is the level and distribution of problem-solving skills in TREs for adults with VET in Europe?
- How is the level and distribution of problem-solving skills in TREs for adults with VET related to adults with other educational backgrounds?

VET adults

- A tendency to have a lack of or low problem-solving skills in all 11 countries
- Only a small minority of VET adults score on the highest level (level 3)
- 63% or more of the adults with VET are below the moderate performance level (level 2)
- More than 11% of the VET adults are at-risk performers in problem-solving



100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Austria
Czech Republic
Denmark
Germany
Slovak Republic
Belgium
Finland
Ireland
Netherlands
Norway
Poland
Work-based
School-based
Level 3
Level 2
Level 1
Below level 1
Not Classified
3
27
35
11
25
4
21
31
16
28
2
23
37
22
16
3
24
34
18
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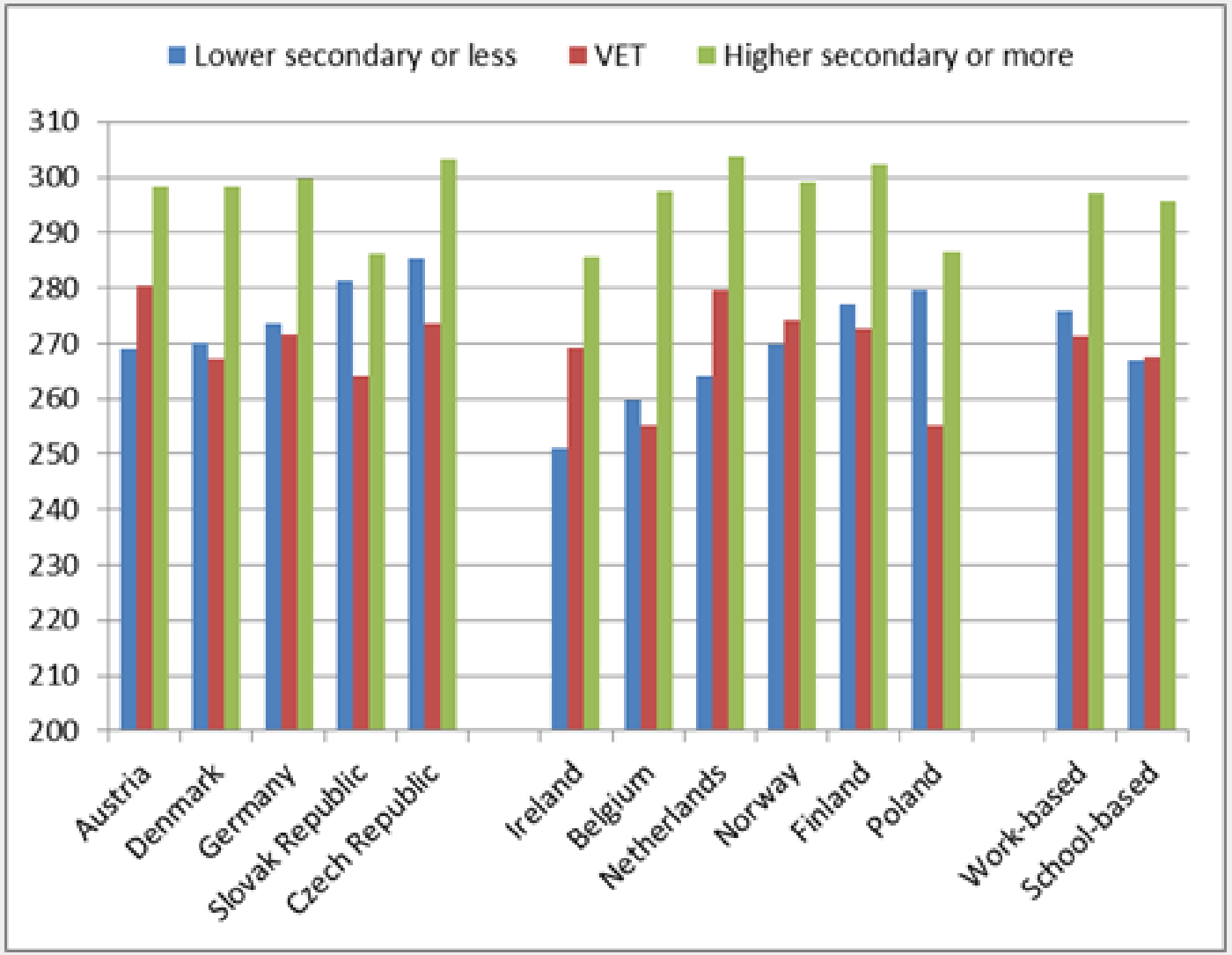
Europe: VET workers' problem-solving skills in technology-rich environments



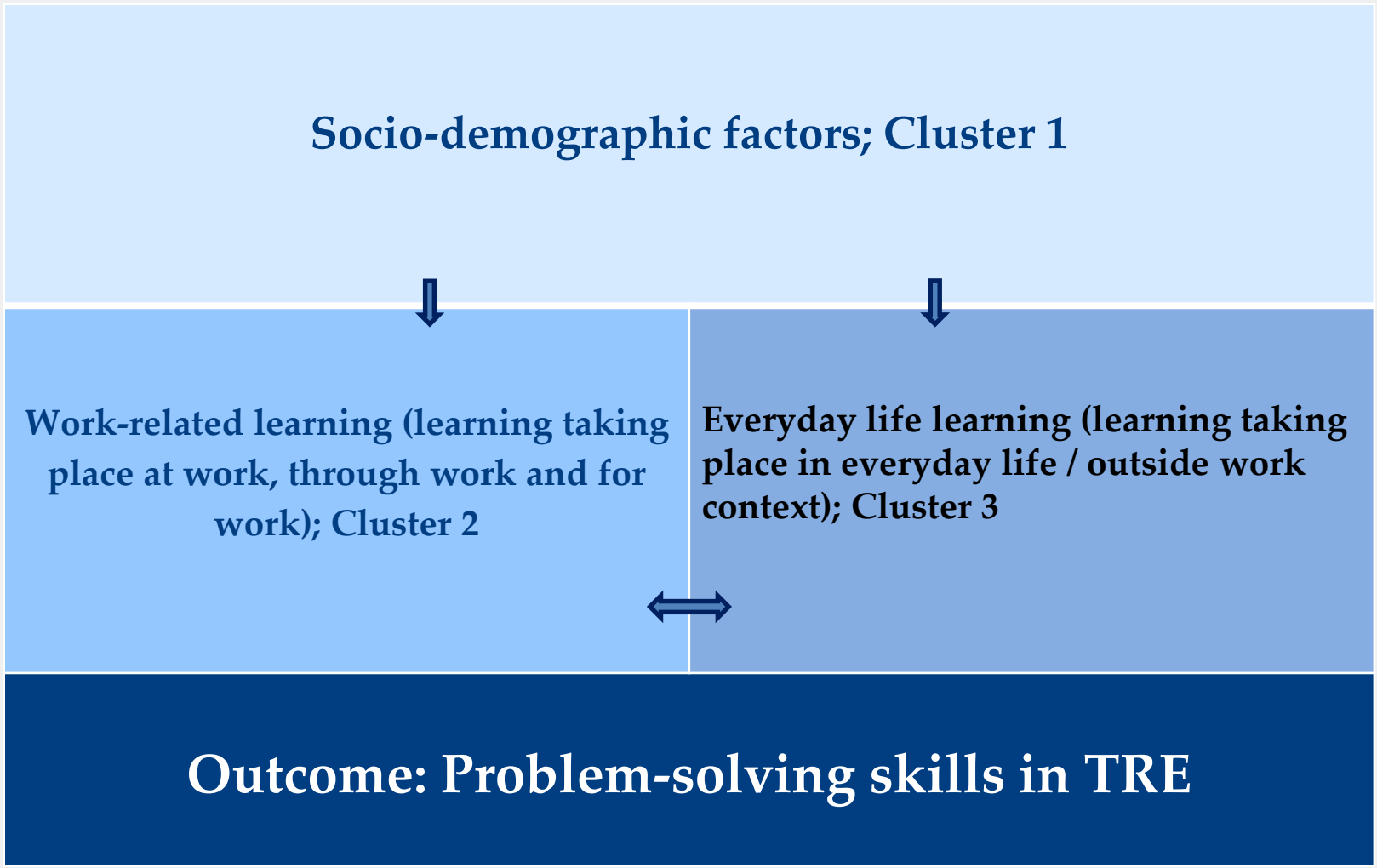
Aim II: The indicators for problem-solving skills differences (Finland)

- What is the level and distribution of problem-solving skills in TRE for adults with VET?
- How is the level and distribution of problem-solving skills in TRE of VET-adults related to adults with other educational backgrounds?
- What factors explain the variation in problem-solving skills in TRE?
- What are the differences in problem-solving between adults with other educational backgrounds and VET adults in predefined age groups, before and after controlling the effects of statistically significant background factors?

Studies II, III, IV, V & VI

The model aims to identify factors explaining the variation in adults' PS skills based on *theoretical assumptions* as well as *empirical support*

Theoretical assumptions



Exploring the differences between adults with VET and other educational backgrounds

- Socio-demographic factors (i.e. cluster 1)
- Socio-demographic and work-related learning factors (= Clusters 1 + 2)
- Socio-demographic and everyday life learning factors (= Clusters 1 + 3)
- All three clusters (i.e. cluster 1+2+3)

Methods:

- Basic descriptive statistics
- Multiple linear regression
- Binary/multinomial logistic regression

A tendency to have low problem-solving skills

The factors explaining the variation in problem-solving in TRE

	Model 1	Model 2	Model 3	Model 4
Socio-demographic factors				
Age (centered at 40 years)	sig.	sig.	sig.	sig.
Education	sig.	sig.	sig.	sig.
Occupation	sig.	sig.	sig.	sig.
Gender	sig.	sig.	sig.	sig.
Work-related learning				
Use of numeracy skills at work	--	sig.	--	n.s.
Use of ICT skills at work	--	sig.	--	sig.
Learning at work	--	sig.	--	sig.
Everyday life learning				
Use of numeracy skills in everyday life	--	--	sig.	sig.
Use of ICT skills in everyday life	--	--	sig.	sig.
Use of reading skills in everyday life	--	--	sig.	sig.

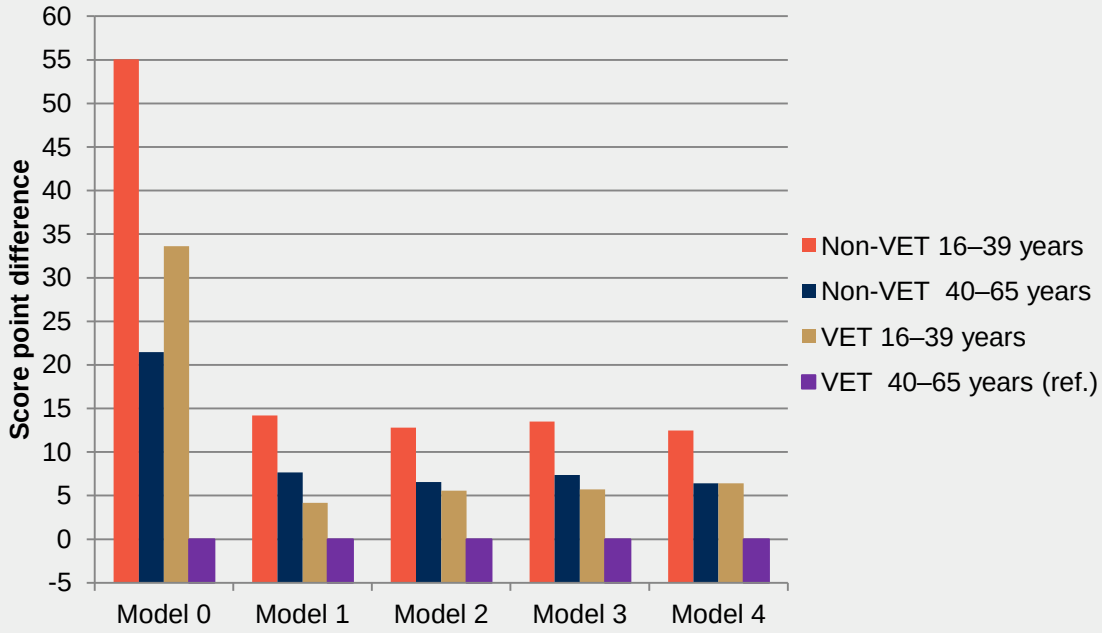
Note: sig. stands for statistically significant effect, $p<.05$.
n.s. stands for not significant

Interesting

Adult education and training?

VET and other educational backgrounds - after controlling the effects of the models

- **The differences in the PS proficiency** of the four categories of adults **are clear**
- The difference between the groups in problem-solving proficiency **changed dramatically after controlling the effects of socio-demographic factors** in Model 1



Aim III: To understand VET adults' strong problem-solving skills in TRE

- What are typical characteristics of strong problem-solvers?
- Which **socio-demographic** factors are associated with VET adults' strong performance in problem-solving in TREs?
- Which factors related to **skills use and learning at work** are associated with VET adults' strong performance in problem-solving in TREs?
- Which factors related to skills **use and learning at everyday life** life are associated with VET adults' strong performance in problem-solving in TREs?

Socio-demographic factors

- The strong performers were
  - younger (mean age 34 years versus 42 years)
  - more often male (65 % vs 56 %)
  - more often skilled occupations (49 % vs 23 %)

Skill use at work

- Active use was more common among the strong performers than among the others
  - numeracy (56 % vs 27%)
  - ICT (41 % vs 17%)
  - reading (54 % vs 30 %) or
  - writing (43 % vs 28 %)

Everyday life learning

- The results on skill use were similar
- The strong performers seemed to have participated in adult education and training, both job-related (68 % vs 46 %) and non-job-related (14 % vs 6 %), more actively than the others

Aim IV: To understand the PS skills of Europe's higher-education adults > Teachers

The problem-solving skills of Europe's higher-education adults

RQ1: What is the level and distribution of problem-solving skills in TRE for adults with HE?

RQ 2: Which factors are associated with strong, or respectively weak, problem-solving in TRE for adults with a HE degree?

Results

Among adults with HE, there is a tendency to have high problem-solving skills

Summary of Significant Factors Explaining Weak and Strong Performance in Different Logistic Regression Models

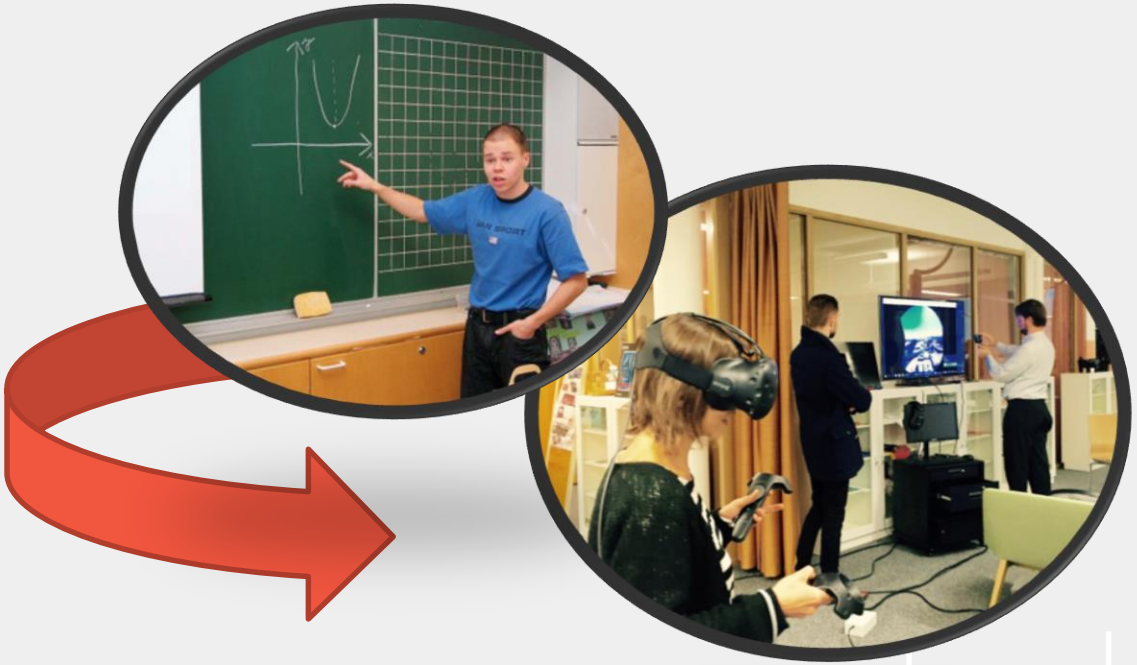
	Model 1		Model 2		Model 3		Model 4	
	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong
$R^2_{Nagelkerke}$ (%)	10.1	6.8	16.5	9.8	15.0	9.4	20.0	11.8
Cluster 1: Socio-demographic factors								
Age	***	***	***	***	***	***	***	***
Gender	***	***	***	**	***	**	***	(ns)
Parental education	***	***	***	***	***	*	**	*
Native speaker	***	*	***	*	***	(ns)	***	(ns)
Cluster 2: Work-related factors								
Occupation			**	*			**	*
ICT skill-use at work			***	(ns)			***	(ns)
Learning at work			(ns)	**			(ns)	**
Adult education or training (job-related)			*	(ns)			**	(ns)
Industry (ISIC)			(ns)	(ns)			*	*
Cluster 3: Everyday life related factors								
Books					***	*	***	*
Numeracy skill-use at home					*	***	(ns)	***
ICT skill-use at home					**	(ns)	(ns)	(ns)
Writing skill-use at home					***	(ns)	***	(ns)
Adult education or training (non job-related)					(ns)	*	(ns)	(ns)

Note. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; (ns) $p > 0.05$

n.s. stands for not significant

Critical

- The problem-solving skills in TRE of people working in education were lower compared to other fields
- Educational workers seem to have fewer opportunities to learn at work



Findings are worrisome and suggest that future studies and new initiatives are needed to help education workers enhance their skills and competencies regarding problem-solving in TRE

INCREASED NEEDS FOR 21ST CENTURY SKILLS

e.g. teaching skills related to technology-enhanced learning.

- **BALANCED RELATION BETWEEN TEACHERS' IDENTITY AND WORK**
  - ***Empowered actor-identity.*** Technologies empowering teaching.

"They're used these days and I think they should be and it's a pleasure to use tools that are utilised on all levels of ICT. It was probably the first time when I've replaced workplace learning's second visit with a video call. It's frustrating to drive to Viitasaari [town in central Finland] for some 20 minute session where you watch some screen, that you should write a two here. When you can easily show the same thing from there."

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- **CONFLICTED RELATION BETWEEN TEACHERS' IDENTITY AND WORK**
  - ***Timed actor-identity.*** Increased work load if technologies do not work.

Vähäsantanen, K. & Hämäläinen, R. (2018). **Professional identity in relation to vocational teachers' work – An identity-centred approach to professional development.** *Learning: Research and Practice.* 1-19.

Whether and how teachers' instructional activities are beneficial in new TEL settings?

Study A

- The goal to understand differences in knowledge construction processes in 3D game settings with and without real-time teachers

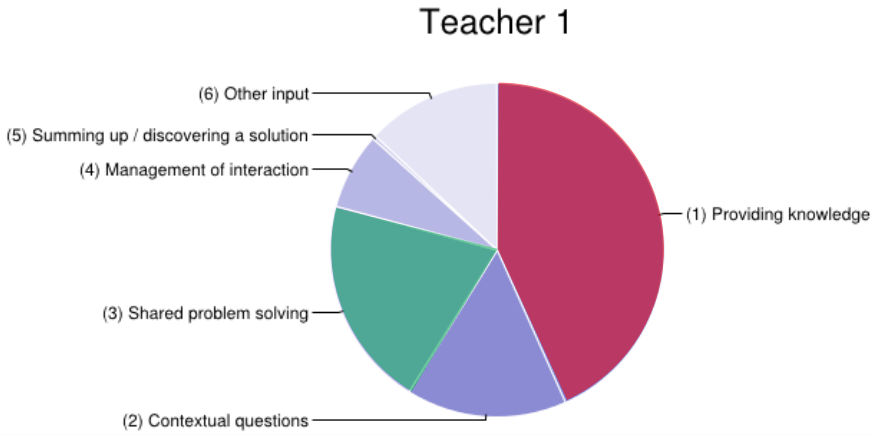
Main findings

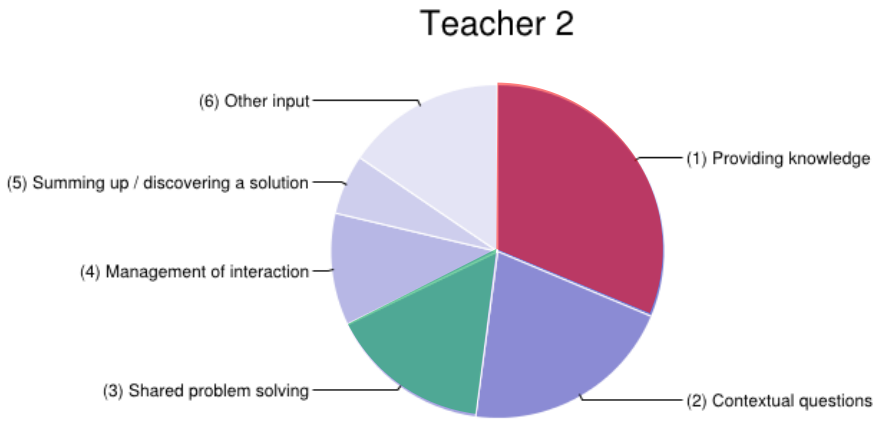
- Groups with real-time teacher instruction - more productive knowledge construction activities; providing knowledge and asking contextual questions
- Groups without real-time teacher 32.6 %: other discussions in the scripted 3D-game setting

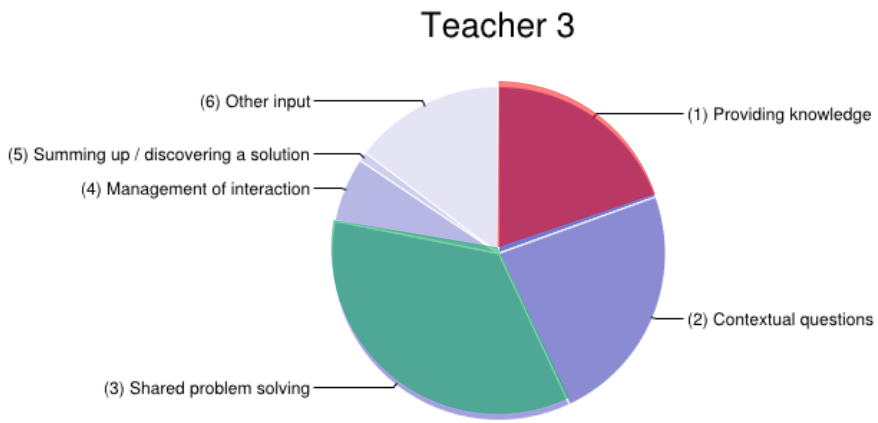
Study B

- How teachers' and students' discussions differed from each other?
- What kind of instructional activities the teachers spontaneously applied?
- How students respond to what teachers do?

Changeing role







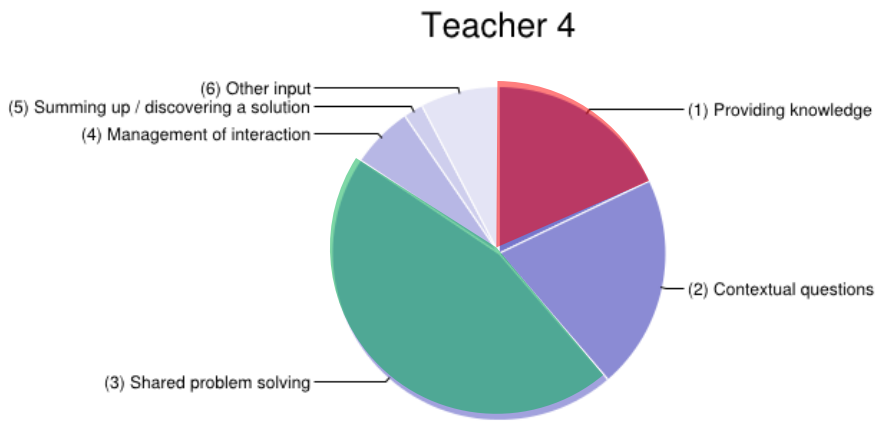


Table 4 Overview of teachers' utterances and the next student utterance divided by group

Teachers' Utterances by category	Group	Following students' utterances by category						
		(1)	(2)	(3)	(4)	(5)	(6)	Total n
(1) Providing knowledge	Group 1	49 %	18 %	5 %	8 %	6 %	14 %	104
	Group 2	52 %	7 %	11 %	4 %	0 %	25 %	71
	Group 3	33 %	21 %	9 %	11 %	1 %	26 %	141
	Group 4	37 %	18 %	26 %	6 %	1 %	13 %	119
	Total	**41 %**	17 %	13 %	8 %	2 %	20 %	435
(2) Contextual questions	Group 1	23 %	9 %	60 %	6 %	0 %	3 %	35
	Group 2	18 %	10 %	62 %	2 %	0 %	8 %	61
	Group 3	19 %	16 %	51 %	5 %	1 %	9 %	166
	Group 4	20 %	11 %	54 %	4 %	1 %	10 %	142
	Total	20 %	13 %	**54 %**	4 %	0 %	9 %	404
(3) Shared problem solving	Group 1	37 %	11 %	24 %	9 %	2 %	17 %	46
	Group 2	23 %	23 %	37 %	9 %	3 %	6 %	35
	Group 3	14 %	22 %	40 %	5 %	0 %	19 %	243
	Group 4	23 %	15 %	43 %	3 %	3 %	12 %	304
	Total	21 %	18 %	**40 %**	5 %	2 %	15 %	628
(4) Management of interaction	Group 1	35 %	6 %	24 %	24 %	0 %	12 %	17
	Group 2	19 %	16 %	45 %	0 %	0 %	19 %	31
	Group 3	23 %	21 %	21 %	16 %	2 %	16 %	43
	Group 4	32 %	20 %	32 %	10 %	0 %	7 %	41
	Total	27 %	17 %	30 %	11 %	1 %	14 %	132
(5) Summing-up/discovering solutions	Group 1	100 %	0 %	0 %	0 %	0 %	0 %	1
	Group 2	30 %	10 %	20 %	20 %	0 %	20 %	10
	Group 3	14 %	14 %	29 %	14 %	0 %	29 %	7
	Group 4	15 %	0 %	54 %	0 %	0 %	31 %	13
	Total	23 %	6 %	35 %	10 %	0 %	26 %	31
(6) Other input	Group 1	50 %	11 %	7 %	4 %	0 %	29 %	28

FUTURE VET

Technological development

- New possibilities:
  - Small business services are gradually using electronic booking systems and taking advance of social media (e.g. using Facebook for marketing).
  - With the aid of new technologies small companies are gaining new access to global markets
- Work places and workers may increasingly benefit from their technological skills and abilities

On the other hand

- Workers must be able to quickly take over new technologies and to solve problems
- Workers are a heterogeneous group and their needs can vary among professionals
- Need for developing new ways to empower professional development

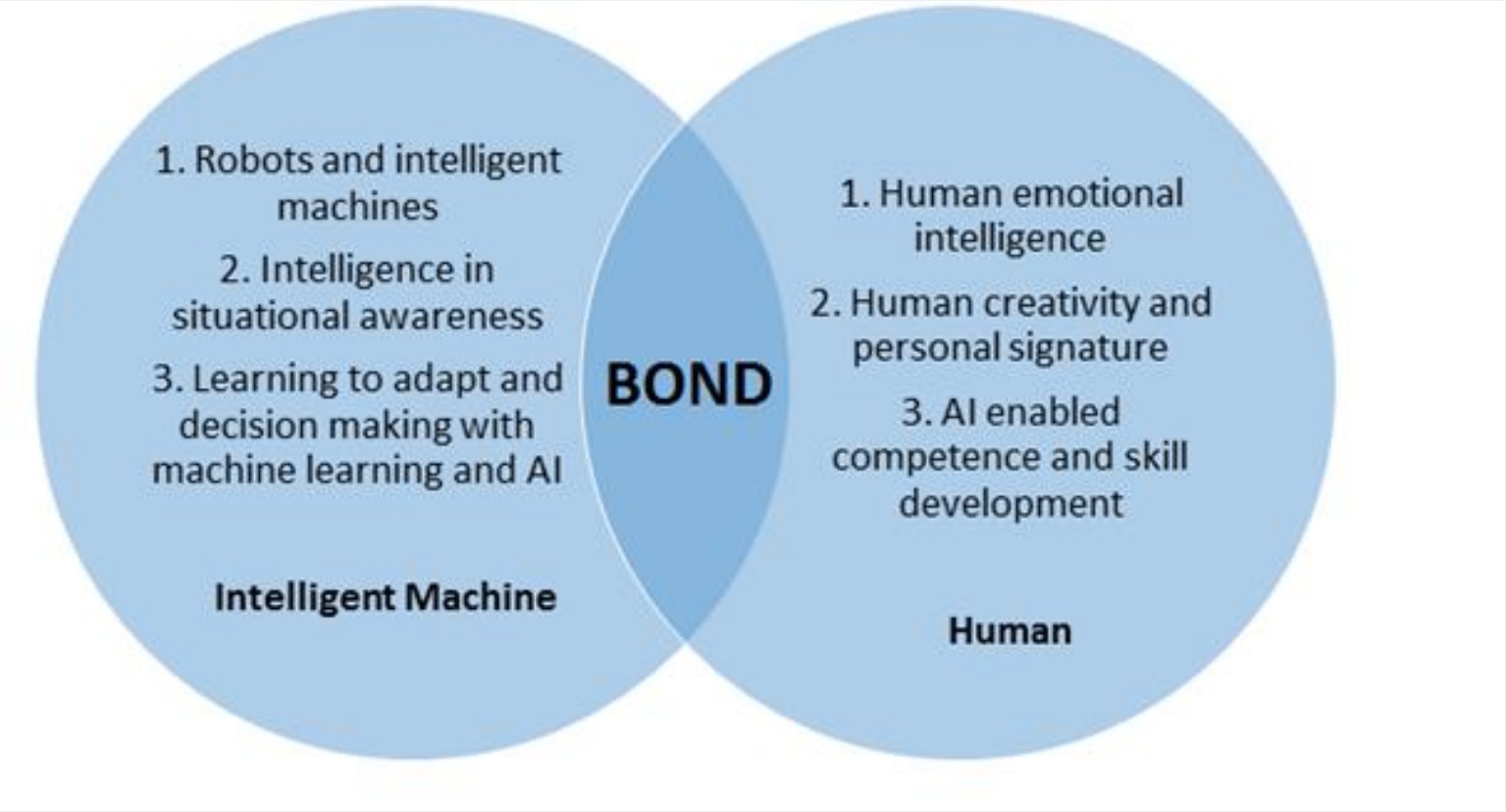
Simulations

Ruoranen, M., Antikainen, T., Mattila, A., Hämäläinen, R. Eteläpelto, A., (2019, in press). Promoting surgical residents' basic skill training via designing and implementing a simulation training tool. Simulation & Gaming

Artificial intelligence: Enabled Human-Machine Collaboration

Collaboration: Tampere University: Technology

To understand the application of artificial intelligence (AI) in human–machine interactions in intelligent (industrial) machines



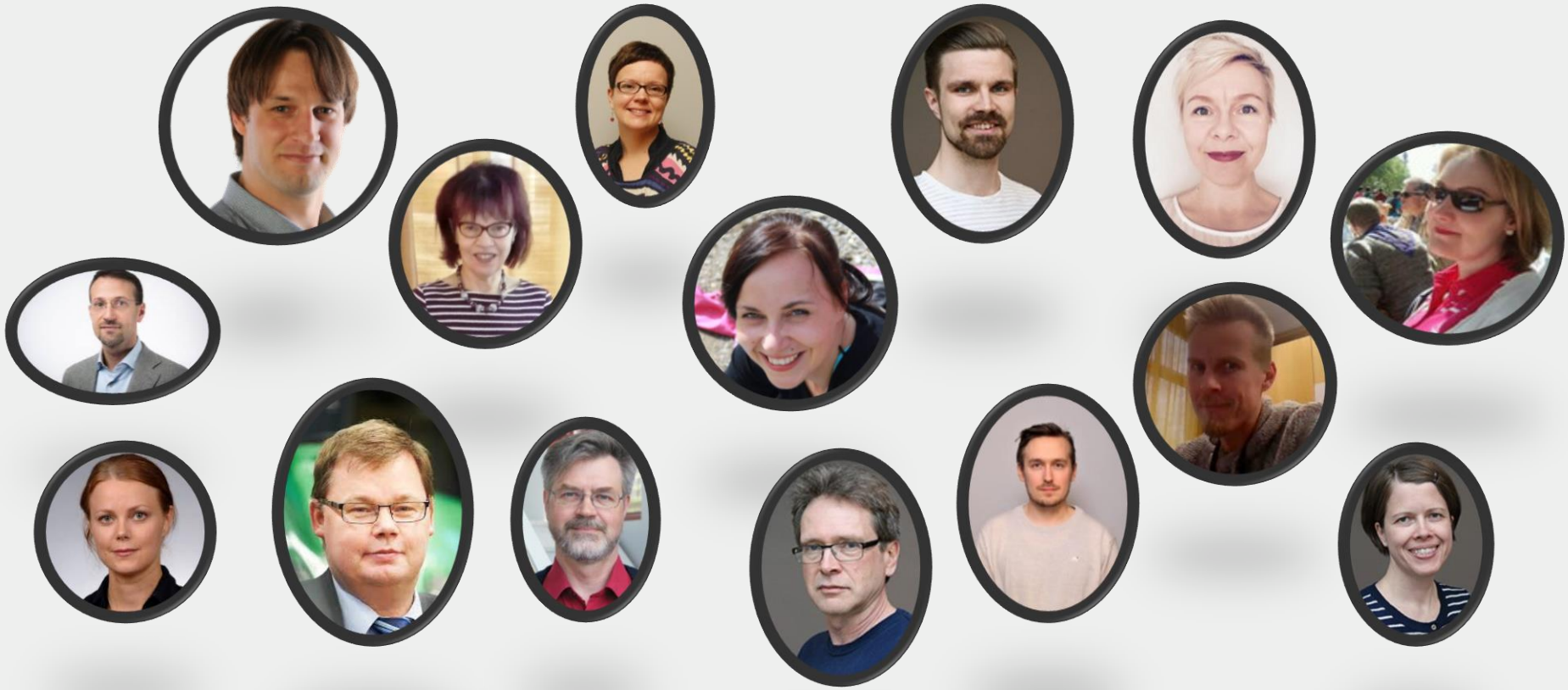
Future ☺

- **Workplace experiences** (Billett, 2019)
- **Agency and emotions** (Eteläpelto, Kykyri, Penttonen, Hökkä, Paloniemi, Vähäsantanen, ... & Lappalainen, 2018).
- **Individual development and professional communities** (Gruber, H., & Harteis, C, 2018).
- **Teachers and teaching** (Moreno Herrera, & Gessler, 2018).

Everyday life

- Living in this century is requiring citizens to have more and more skills to solve problems in TRE
- The Internet and related applications are often used for leisure activities
- Adults' educational background seems to be associated with how technologies are used in everyday life

- PhD students: Joni Lämsä, Hanna Nygren, Kirsi Heinonen, Jiri Vilppola, Kati Laine, Minna Ruoranen, Joonas Mannonen, and Sebastiano Cincinnato
- Professors: Bram De Wever, Alberto Cattaneo, Kari Koskinen, Minna Lanz, Antero Malin and Anneli Eteläpelto
- University researchers: Dr. Katja Vähäsantanen and Dr. Kari Nissinen



Thanks!

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Refereces

- Hämäläinen, R., De Wever, B., Nissinen, K., & Cincinnato, S. (2019). **What makes the difference – PIAAC as a resource for understanding the problem-solving skills of Europe's higher-education adults.** *Computers & Education*. 129. 27-36.
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