International Symposium on STEM Education (ISSE) 2016
Lahti, Finland, June 6th to 8th, 2016

The Opportunities and Challenges for ICT in Science Education – *Teachers' Perspectives*

Vesna Ferk Savec, University of Ljubljana

Lahti, Finland, June 8th 2016

How Do We Teachers Feel about the Information Age?

Satisfied and effective?

Overwhelmed ?

Lost?

How Do We Teachers Feel about the Information Age?

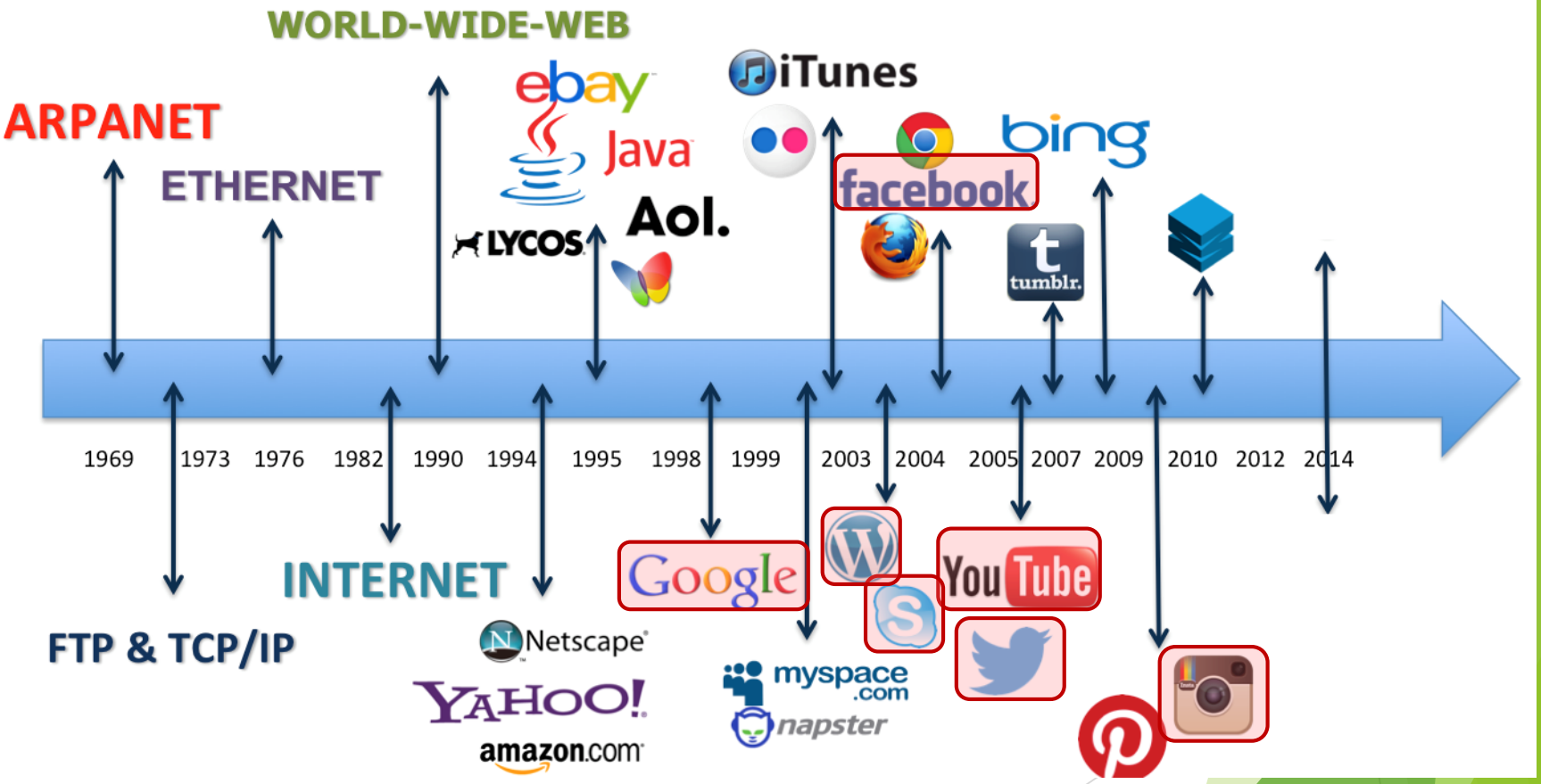
‘Every two days now we create as much information as we did from the dawn of civilization up until 2003…’

‘I spend most of my time assuming the world is not ready for the technology revolution that will be happening to them soon…’

(Eric Schmidt, former CEO of Google)

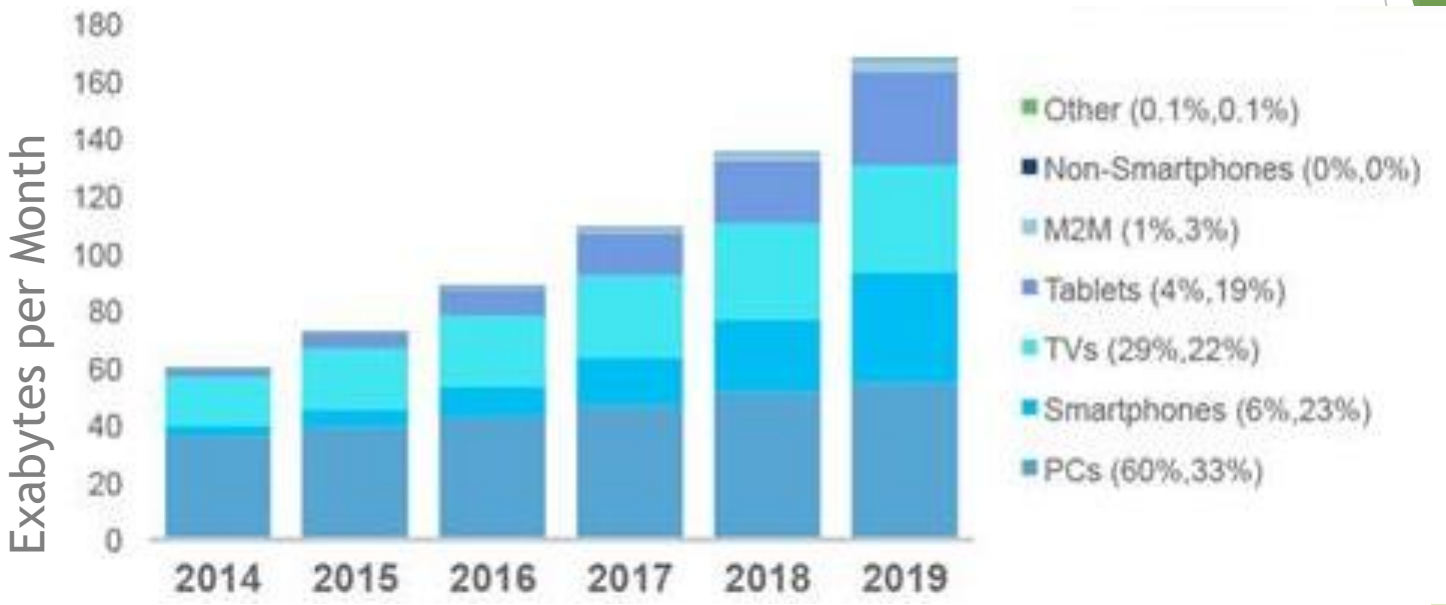
Source: UC Berkeley's School of Information Management and Systems [cited 5.6.2016]

History of the Internet - Timeline



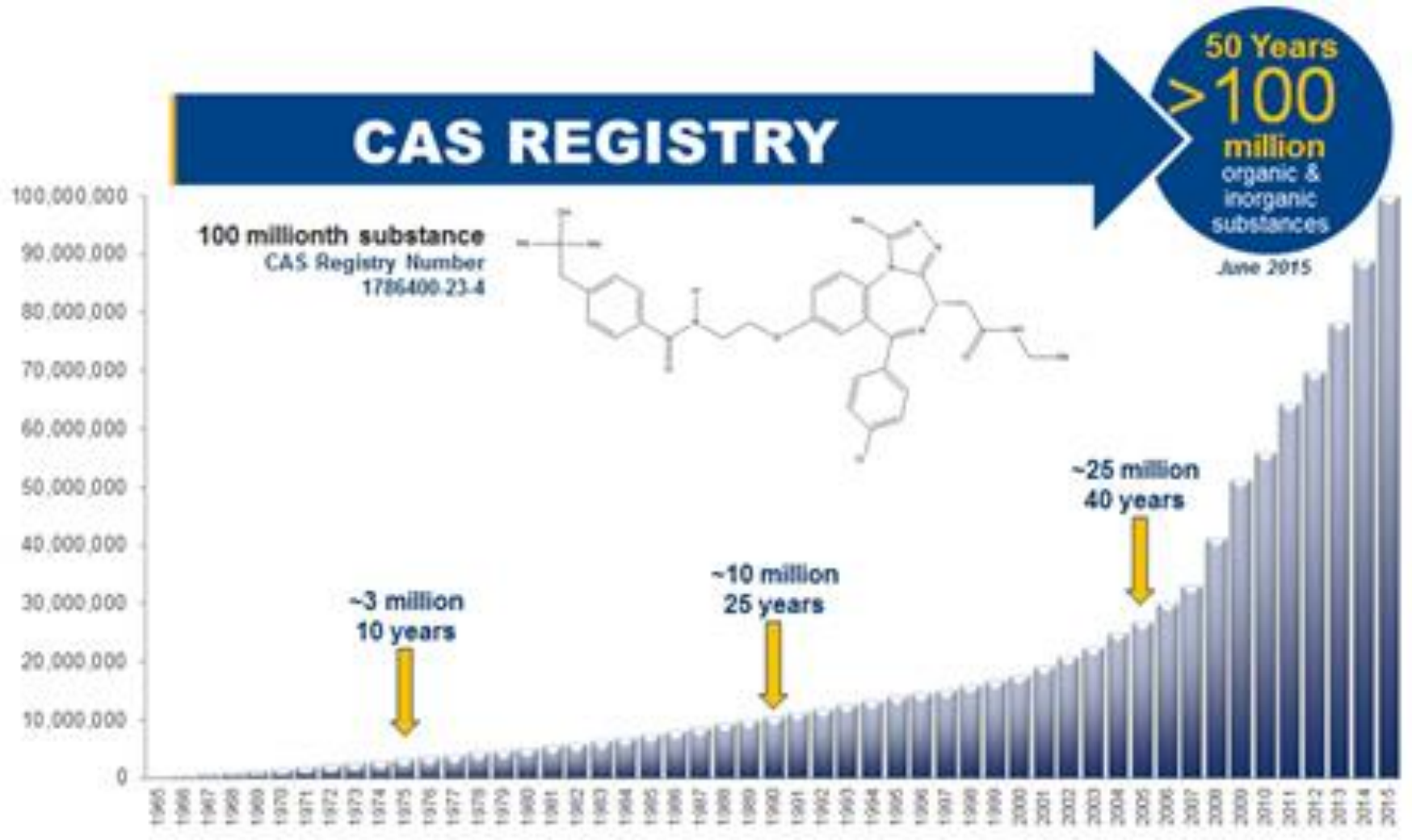
Source: Malonemediagroup [cited 5.6.2016]

Trends in Global IP Traffic by Device



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019 [cited 5.6.2016]

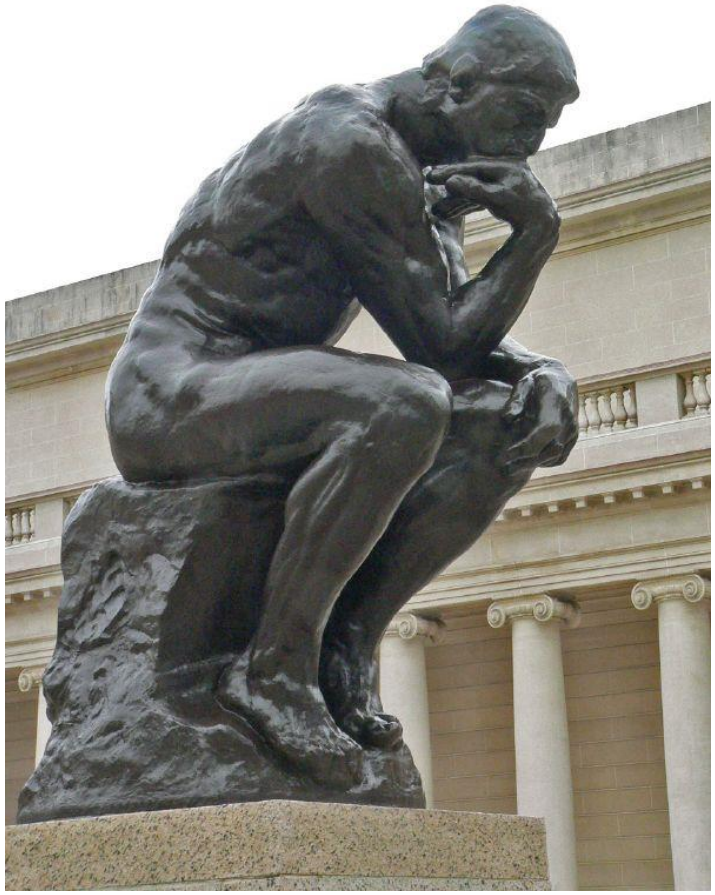
Exponential Growth of New Compounds



The number of registered compounds in CA Registry

(CAS, 2015)

How to be an Effective Teacher in the Information Age

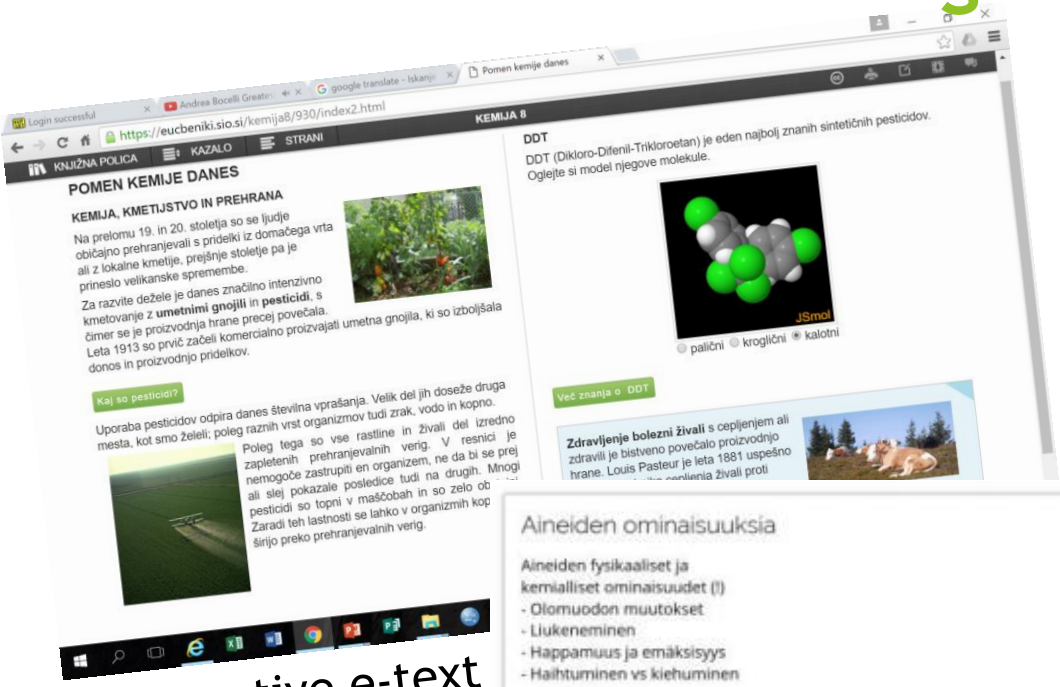


Rodin's *Thinker*

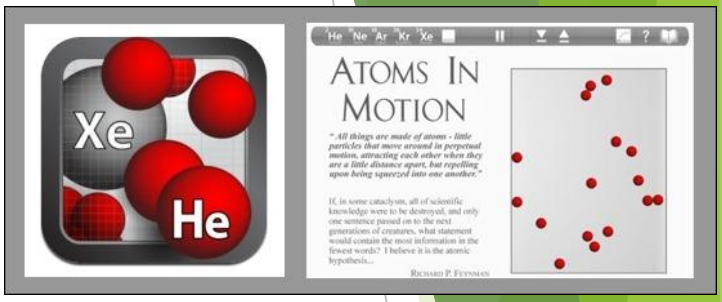
How to be an Effective Teacher in the Information Age

MADropolitan Museum of Art's
'The Texter'

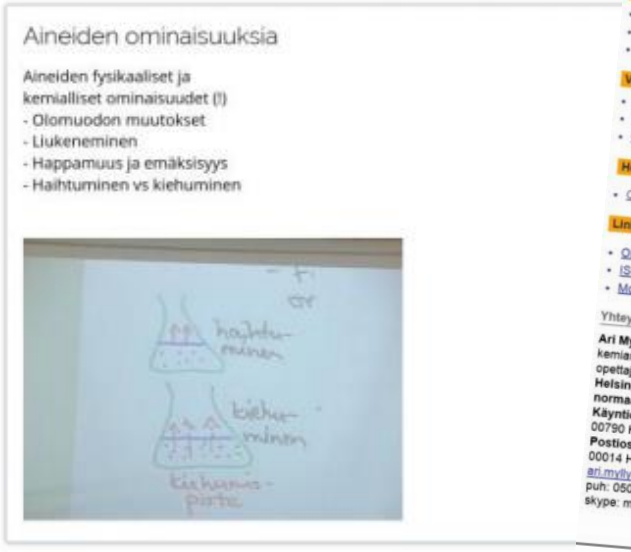
Existing Good Practices of the Use of ICT in Learning Science



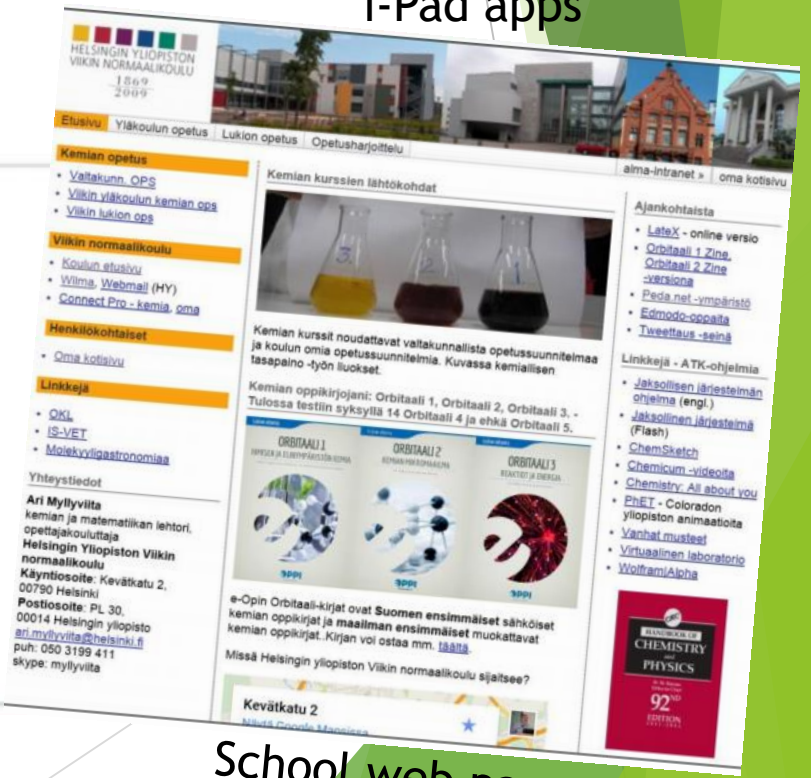
Interactive e-text books



i-Pad apps



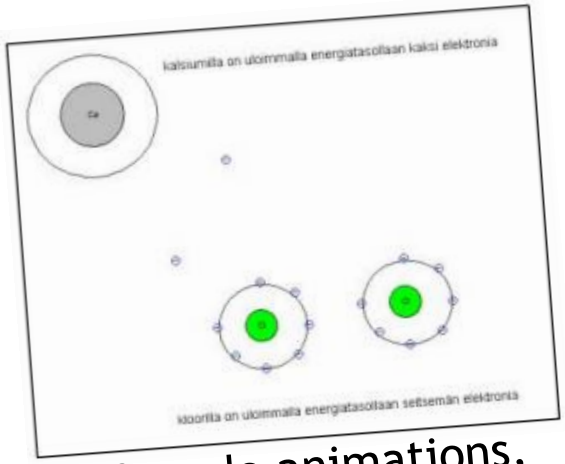
Editable e-notebooks



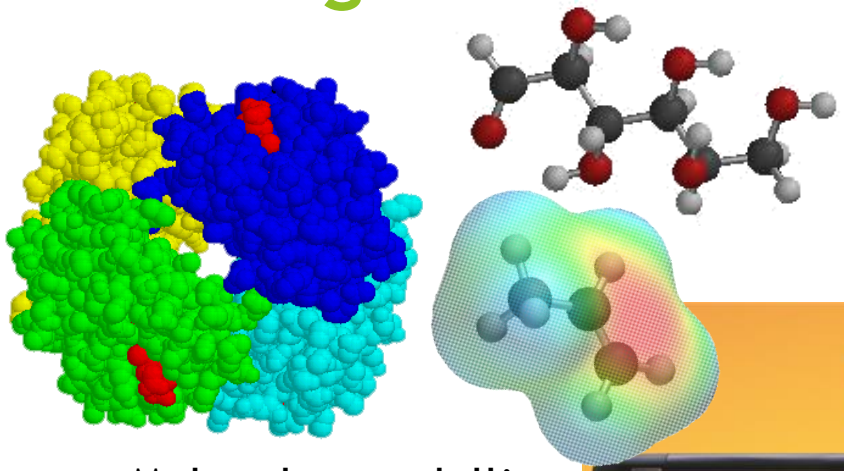
School web pages

Source: https://eucbeniki.sio.si/; http://www.myllyviita.fi/[cited 5.6.2016]

Existing Good Practices of the Use of ICT in Learning Science

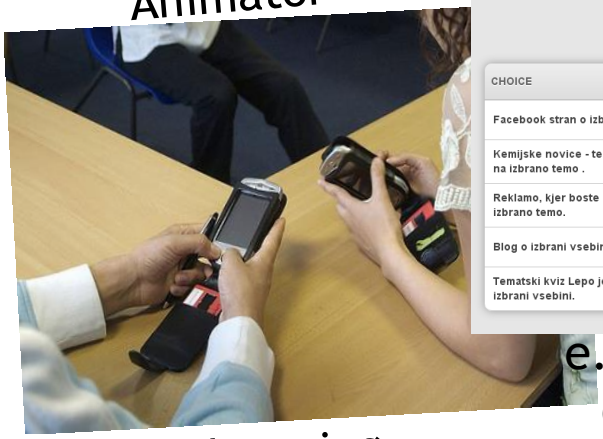


Self-made animations, e.g. Chem Sense Animator

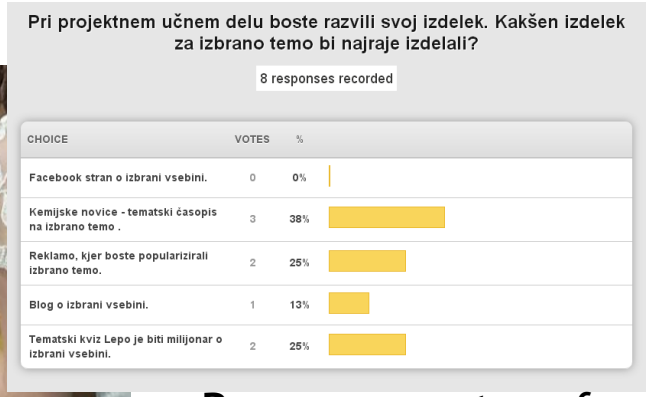


Molecular modelling

Interactive whiteboards



m-learning



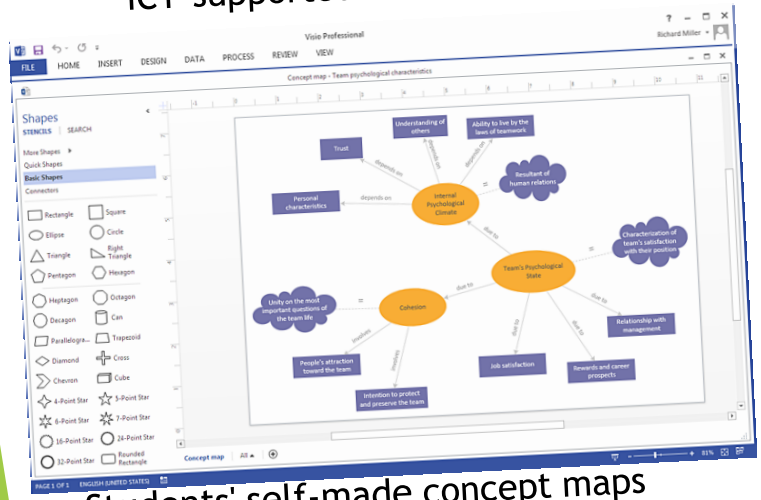
e.g. Response system for educators GoSoapBox

Existing Good Practices of the Use of ICT in Learning Science

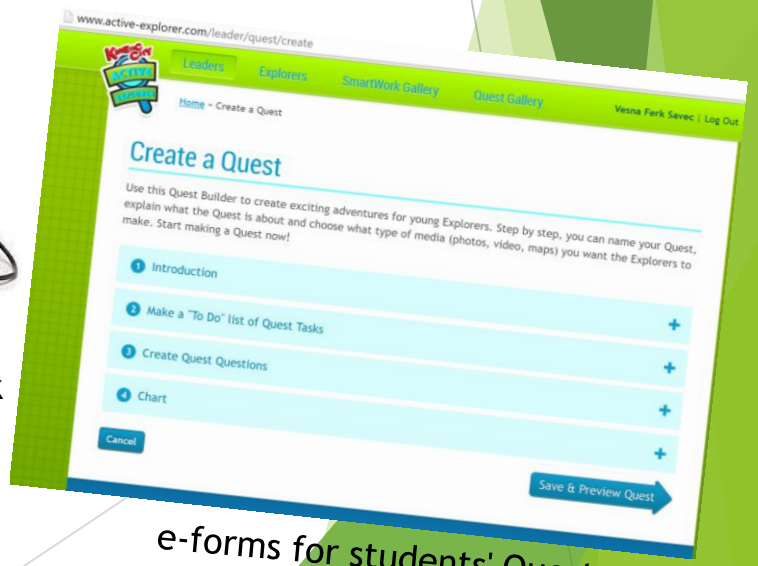
ICT-supported data collection

ICT-supported student presentations of project work

ICT-supported experimental work

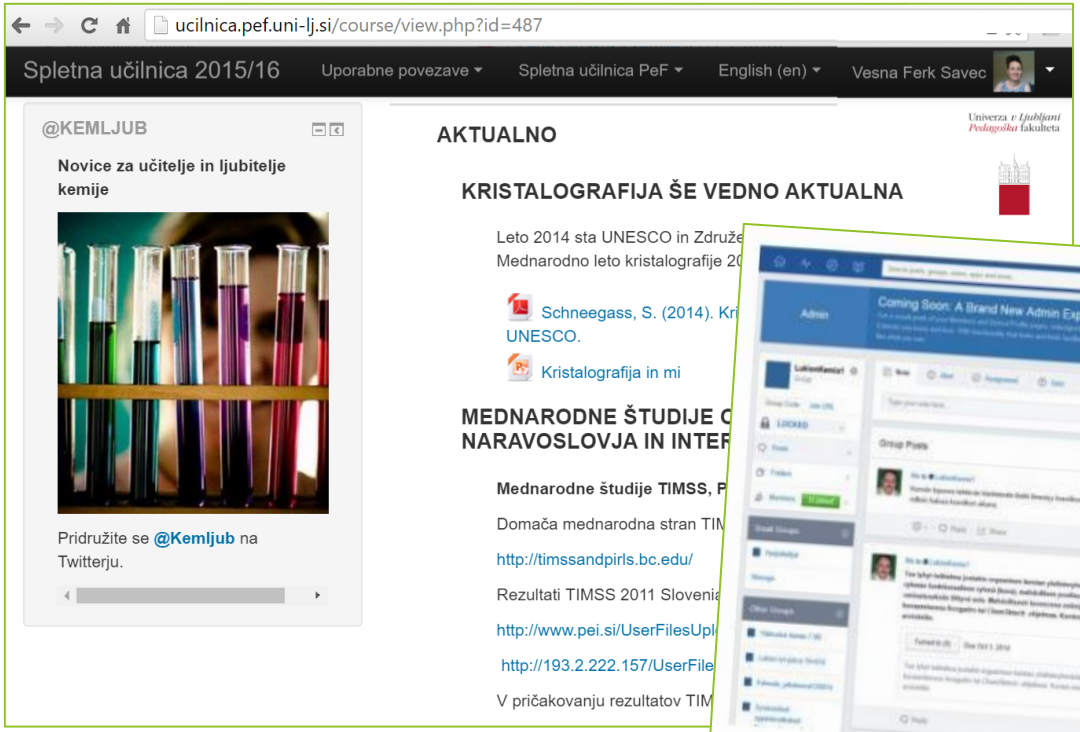


Students' self-made concept maps



e-forms for students' Quests

Existing Good Practices of the Use of ICT in Learning Science

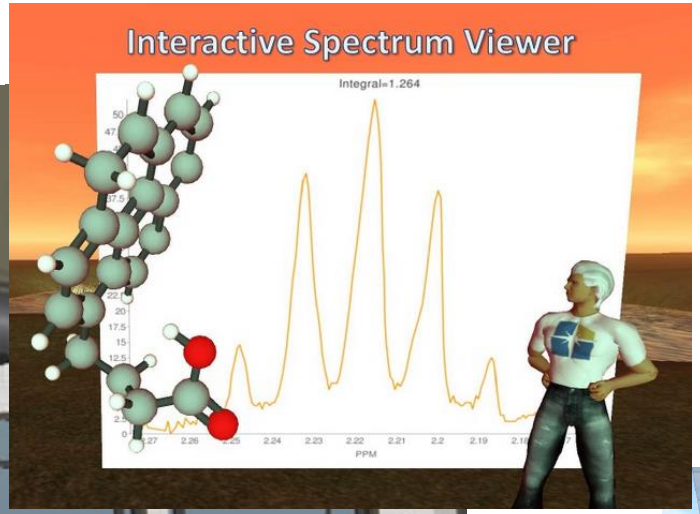


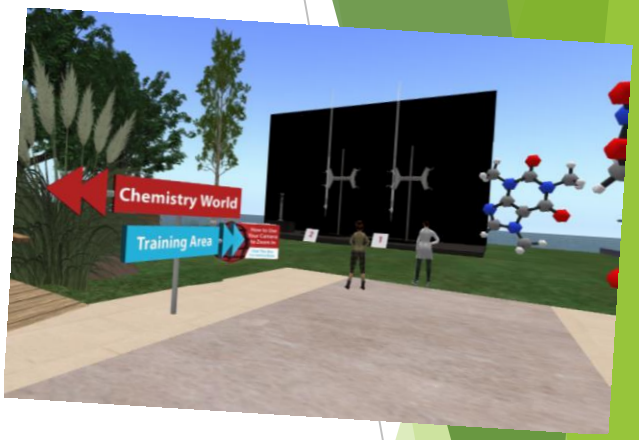
http://ucilnica.pef.uni-lj.si/my/
[cited 5.6.2016]

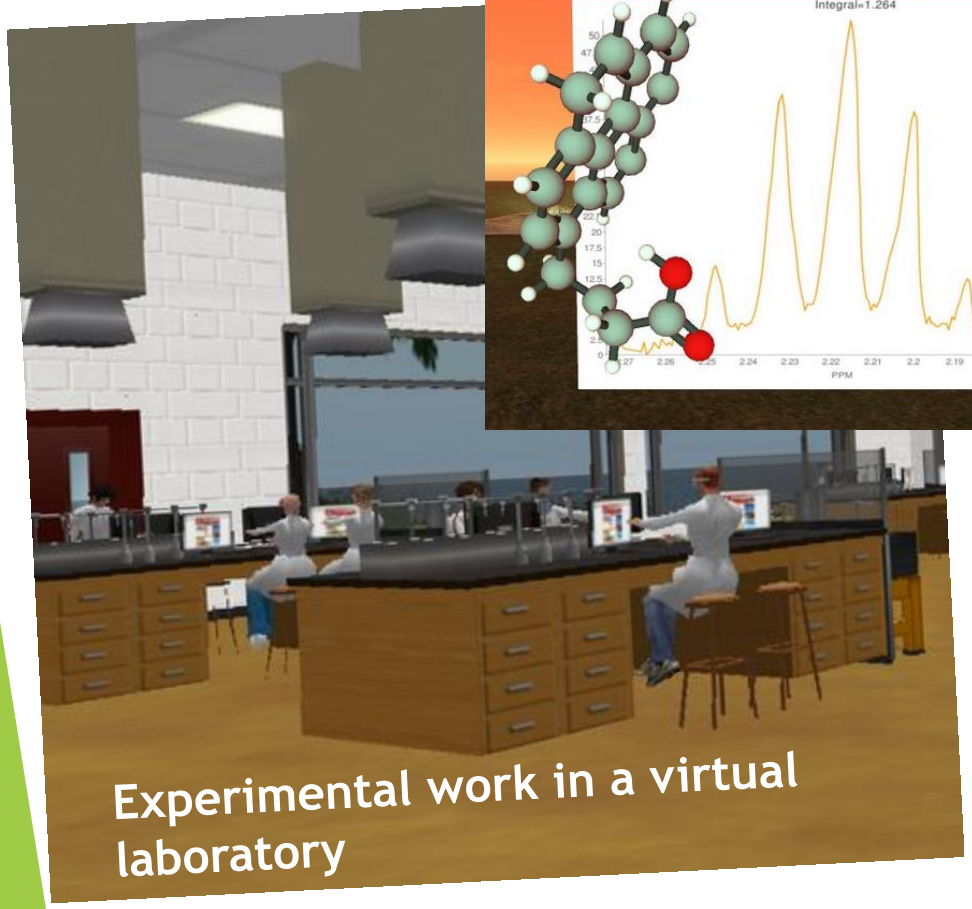
http://www.myllyviita.fi/
[cited 5.6.2016]

Virtual study environments

Existing Good Practices of the Use of ICT in Learning Science







Learning in virtual reality e.g. “Second life”

Existing Good Practices of the Use of ICT in Learning Science

https://twitter.com/kemljub [cited 5.6.2016]

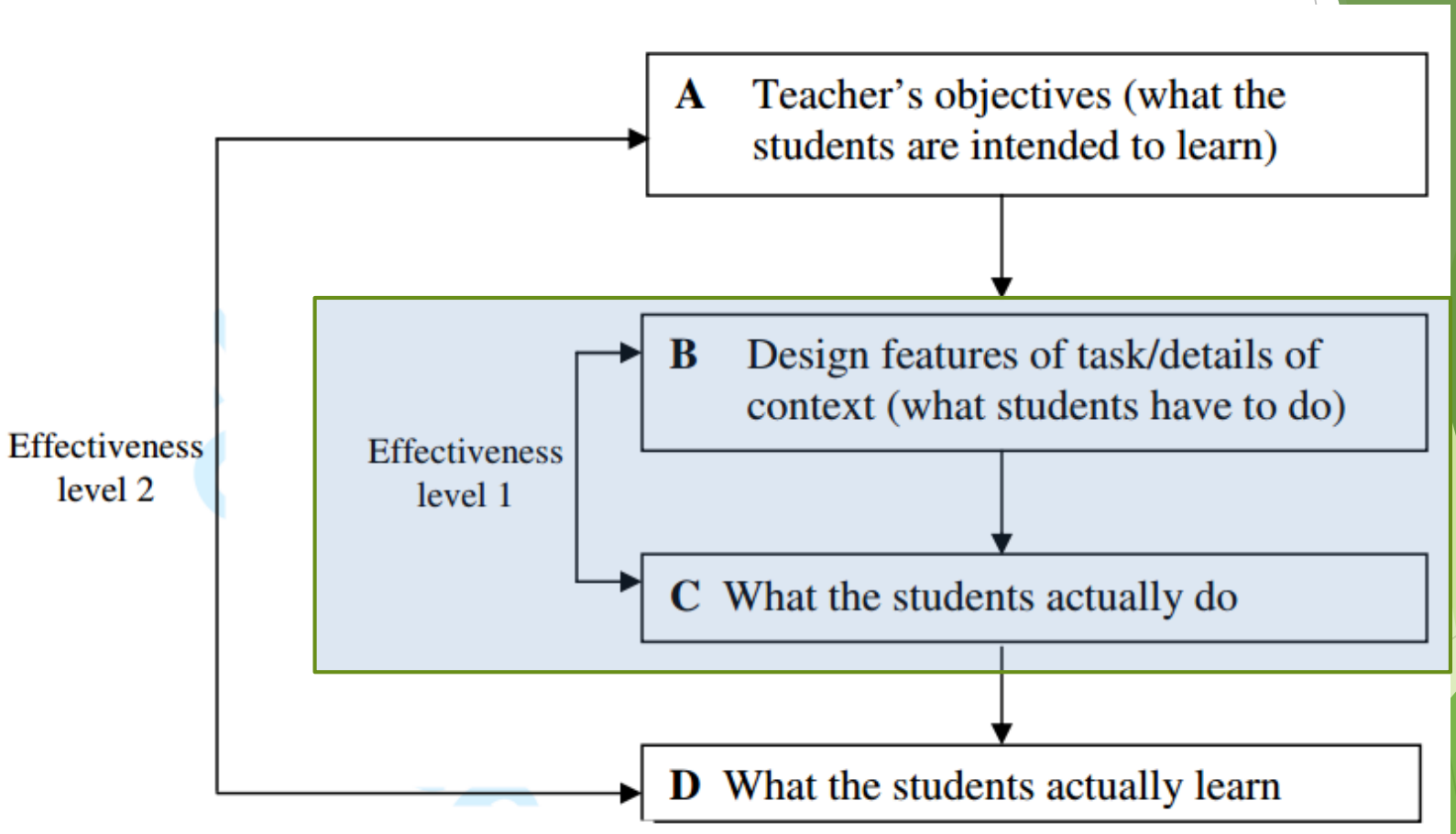
http://www.myllyviita.fi/ [cited 5.6.2016]

What the Research Says About **Efficient Learning** by the Use of ICT?

People learn best when (Tamis-LeMonda, Kuchirko, Song, 2014; Hirsh-Pasek et al., 2015):

- they are ***actively* involved** ('minds-on'),
- ***engaged*** with the learning materials and undistracted by peripheral elements,
- have ***meaningful*** experiences that relate to their lives,
- ***socially interact*** with others in high-quality ways around new material,
- within a context that provides a ***clear learning goals.***

Model of the Process of Design and Evaluation of Students' Activity



(Abrahams and Millar, 2008)

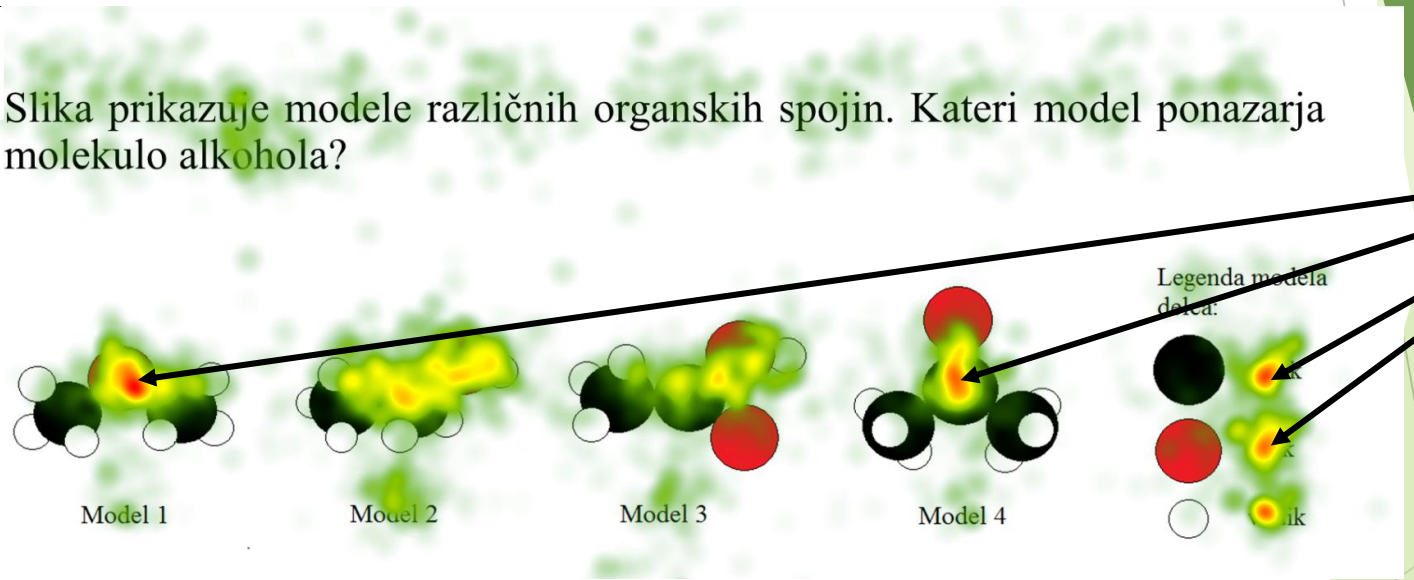
What the Research Says About Pitfalls to avoid when Learning with the Use of ICT?

Students **using laptops in taking notes :**

- are not mind-on task during lectures (Kay & Lauricella, 2011; Kraushaar & Novak, 2010; Skolnick & Puzo, 2008; Sovern, 2013),
- show decreased academic performance (Fried, 2008; GraceMartin & Gay, 2001; Kraushaar & Novak, 2010),
- are less satisfied with their education than their peers who do not use laptops in class (Wurst, Smarkola & Gaffney, 2008).

The Use of Emerging Research Devices to Study Learning with the Use of ICT

EyeTracker heat map (Ferk Savec, Svetičič, Slapničar, Devetak, 2016)
(average *fixation time* on particular *areas of interest*)



Area of interest	Total Fixation Duration - Model 1 [s]	Total Fixation Duration - Model 2 [s]	Total Fixation Duration - Model 3 [s]	Total Fixation Duration - Model 4 [s]	Total Fixation Duration - Legend [s]
Particular particles, legend	2.88	4.13	3.01	2.1	3.23
All particles, legend	12.27				3.23

Teachers are the Key for the Efficient Integration of ICT in Learning

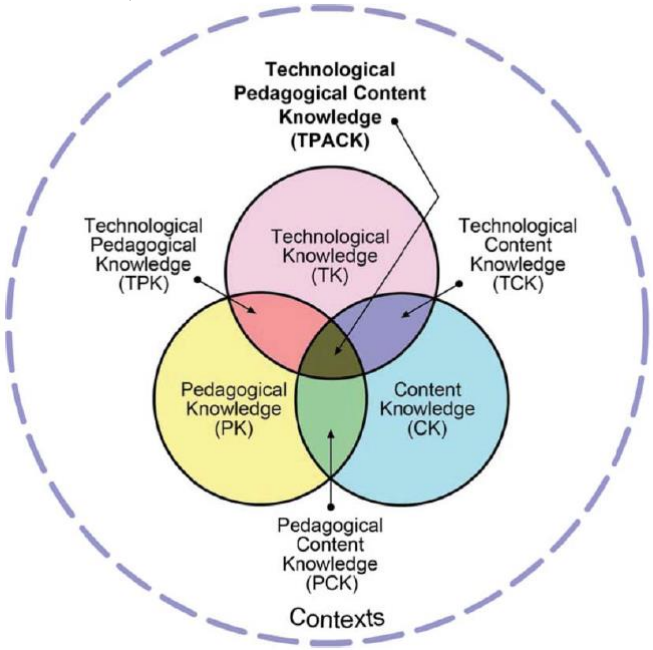
- Teachers' professional development is the key for successful integration of ICT at school level (Ertmer & Ottenbreit-Leftwich, 2010; Clarks & Hollingsworth, 2002; Pernaa & Aksela, 2009),
- Teachers' participation in subject-specific ICT training increased ICT integration in the classroom (Voogt, 2010; Rogers & Twidle, 2014) .

Technological Pedagogical Content Knowledge (TPCK)

- Based on Shulmans' (1986) concept of Pedagogical Content Knowledge (PCK), Mishra & Koehler (2006) introduced a concept of Technological Pedagogical Content Knowledge (TPCK).
- TPCK is the overlap of several domains of knowledge.
  - **Technological knowledge (TK)** is continuously changing knowledge about how to use various software and hardware.
  - **Pedagogical knowledge (PK)** is knowledge of all processes of teaching and learning
  - **Content knowledge (CK)** is knowledge of a subject matter.

Technological Pedagogical Content Knowledge (TPCK)

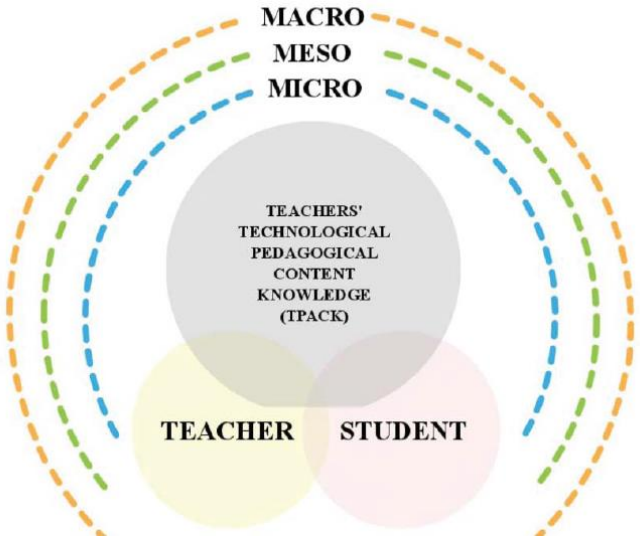
TPCK is dynamic, integrative and transformative knowledge of technology, pedagogy and the content of a subject matter needed for pedagogically meaningful integration of ICT in teaching (Mishra & Kohler, 2006; Koehler et al., 2007; Rogers & Twidle, 2014).



Conceptual Framework for Context

The changes in teachers' TPCK are a function of (Porras-Hernandez and Salinas-Amescua, 2013; Rosenberg & Koehler, 2015):

- **Micro Factors** at the classroom level (or learning environment)
- **Meso Factors** at the school level (or community level)
- **Macro Factors** at the societal level



…. and two associated actors:

- **Teacher factors**
- **Student factors**

TPCK Research

Research areas (Voogt, Fisser, Roblin, Tondeur & Braak, 2012):

- Development of the TPCK concept (general)
- Development of the TPCK concept (subject specific)
- Views on technological knowledge
- TPCK and teachers' beliefs
- Measuring (student-)teachers' TPCK
- Strategies for developing (student-) teachers' TPCK

TPCK and Teachers' Beliefs

- Teachers who were competent using ICT in their personal life were more confident using ICT in the classroom (Prestridge, 2012).
- Teachers who use more technology are more competent and confident using it but also more open to new ideas and more likely to use ICT in the classroom successfully (Paraskeva & Angeli, 2008; Prestridge, 2012).
- Becoming familiar with technologies teachers' positive attitudes toward ICT may be developed, followed by the increased ICT integration in the classroom (Tezci, 2010).

Teachers' Self-Confidence and Computer Skills (Helppolainen & Aksela, 2015)

	Chemistry teachers (N88)		Other teachers (N102)	
	Mean	S.D.	Mean	S.D.
I can select appropriate software to use in my teaching	3.83	1.116	3.63	1.116
I can use PowerPoint in my class	4.57	1.087	4.25	1.087
I can design technology-enhanced learning activities for my students	3.30	1.305	3.31	1.305
I can use email to communicate with my students	4.47	1.083	4.24	1.083
I can teach my students to select appropriate software to use in their projects	3.31	1.245	3.40	1.245
I can teach my students how to make their own web pages	1.92	1.602	2.54	1.602
I can use the Internet in my lessons to meet certain learning goals	3.98	0.994	4.04	0.994
The computer can help students understand concepts more easily	3.77	0.892	3.76	0.892
I feel comfortable with the idea of the computer as a tool in teaching and learning	4.40	0.781	4.30	0.806
The use of computers in teaching and learning stresses me out	2.65	1.263	2.83	1.203
If something goes wrong I will not know how to fix it	2.55	1.016	2.66	1.121
The idea of using a computer in teaching and learning makes me skeptical	2.01	1.000	2.12	1.163
The use of the computer as a learning tool excites me	3.93	0.920	3.83	0.945
The use of computers in teaching and learning scares me	1.81	1.049	1.91	1.045
The computer is a valuable tool for teachers	4.68	0.468	4.44	0.791
The computer will change the way I teach	4.09	0.737	3.97	0.789
I can do what the computer can do equally as well	2.59	0.905	2.81	0.887
The computer is not conducive to student learning because it is not easy to use	2.16	0.829	2.09	0.891
The computer helps students understand concepts in more effective ways	3.31	0.939	3.23	0.900
The computer helps students learn because it allows them to express their thinking in better and different ways	3.34	0.908	3.21	0.958
The computer helps teachers to teach in more effective ways	3.73	0.991	3.60	0.947
The computer is not conducive to good teaching because it creates technical problem	2.61	1.108	2.61	0.987

Scale: 1 “Completely disagree”, 2 “Disagree”, 3 “Neutral”, 4 “Agree”, 5 “Completely agree “.(Papanastasiou & Angeli, 2008)

Teachers' Attitudes towards Computers

(Helppolainen & Aksela, 2015)

	Chemistry teachers (N88)		Other teachers (N102)	
	Mean	S.D.	Mean	S.D.
ICT increases the ways of teaching and learning	0.90	0.305	0.88	0.353
ICT helps learners to find new information	0.80	0.483	0.75	0.501
ICT makes lesson diverse	0.88	0.333	0.78	0.480
ICT improves learners presentations/assignments	0.66	0.585	0.44	0.739
ICT increases motivation	0.45	0.642	0.40	0.601
ICT supports independent learning	0.40	0.653	0.45	0.591
ICT enhances subject learning	0.26	0.652	0.28	0.723
ICT supports collaboration	0.25	0.682	0.20	0.690
ICT makes working faster	0.19	0.771	0.15	0.837
ICT makes learners work harder	-0.09	0.721	0.03	0.710
ICT disturbs in pupils' concentration	-0.06	0.684	-0.15	0.737

Scale: 1 "Agree", -1 "Disagree", 0 "Neither". (Wikan & Molster, 2011)

Teachers' Evaluation of Areas for which Support is Needed (Helppolainen & Aksela, 2015)

	Chemistry teachers (N88)		Other teachers (N102)	
	Mean	**S.D.**	**Mean**	**S.D.**
Lack of appropriate software/materials	3.53	1.164	3.45	1.256
Lack of appropriate course content and instructional programs	3.51	1.135	3.56	1.157
Lack of basic knowledge/skills for ICTs	2.58	1.354	2.71	1.383
Lack of basic knowledge/skills for ICT integration	3.05	1.268	2.97	1.164
Lack of in-service training	3.44	1.276	3.37	1.242
Lack of hardware	3.95	1.231	3.59	1.381
Lack of technical support	3.55	1.240	3.45	1.347
Lack of time	4.14	1.008	3.89	1.052
Lack of appropriate administrative support	2.81	1.240	2.91	1.336

Scale: 1 “Completely disagree”, 2 “Disagree”, 3 “Neutral”, 4 “Agree”, 5 “Completely agree “. (Goktas et al., 2009)

‘The only thing that is constant is change’

(Heraclitus, 535 BCE - 475 BCE)

Kiitos!

vesna.ferk@pef.uni-lj.si