

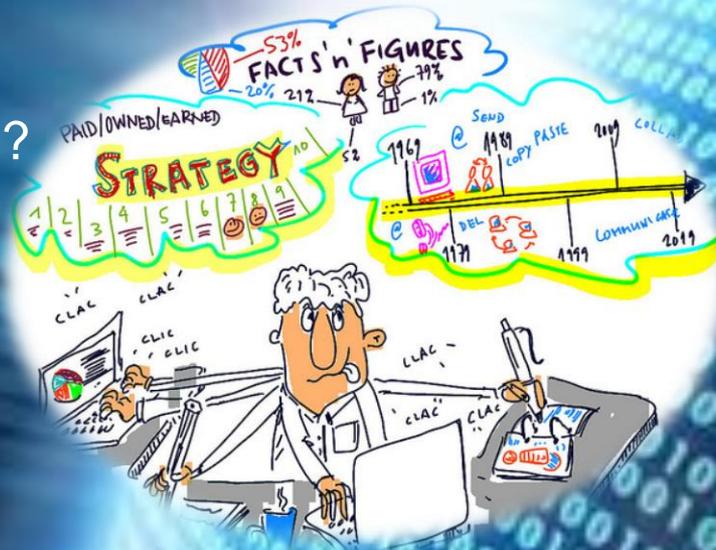
*International Symposium on STEM Education (ISSE) 2016
Lahti, Finland, June 6th to 8th, 2016*

**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?

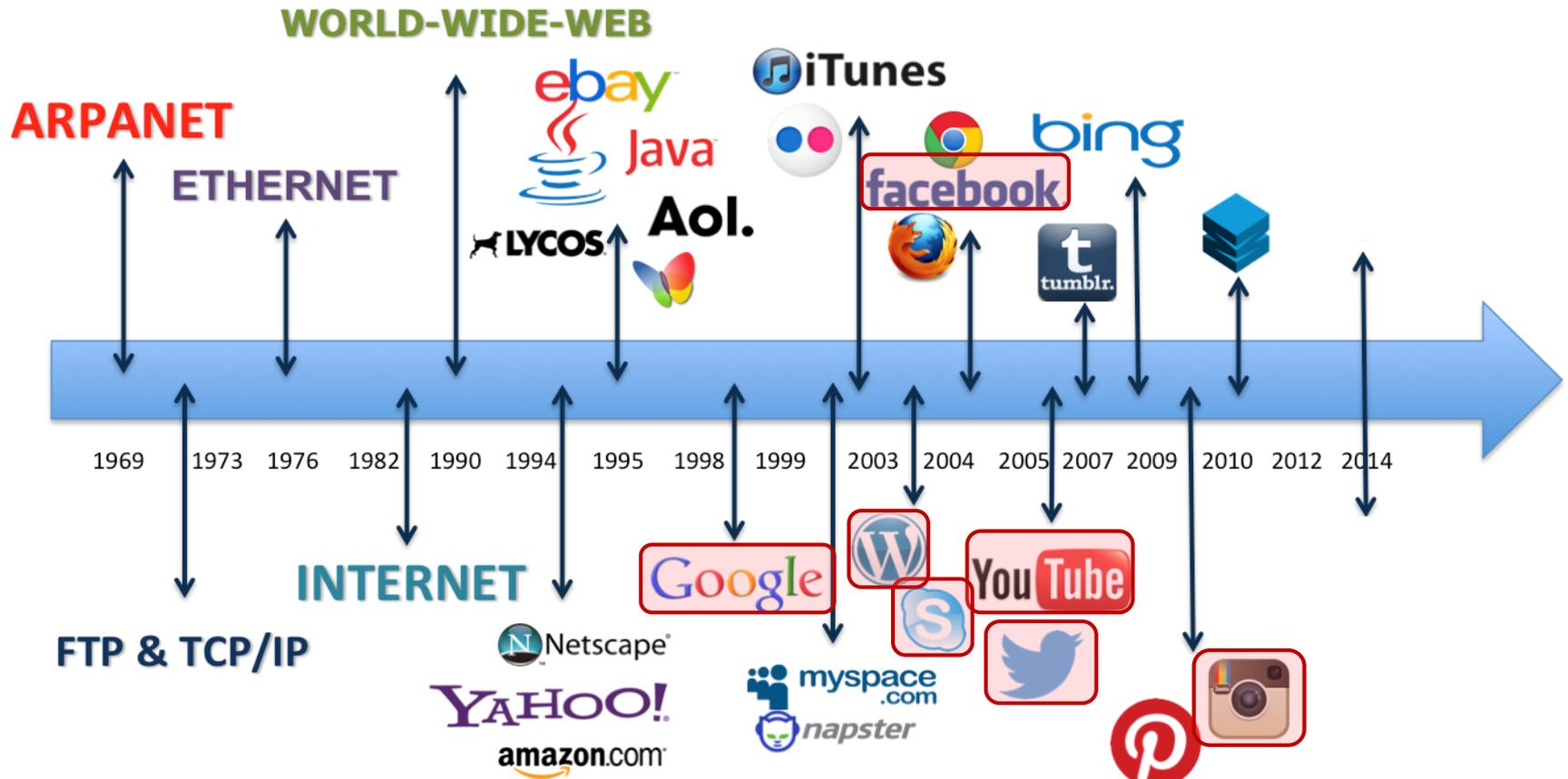
How Do We Teachers Feel about the Information Age?

‘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...’

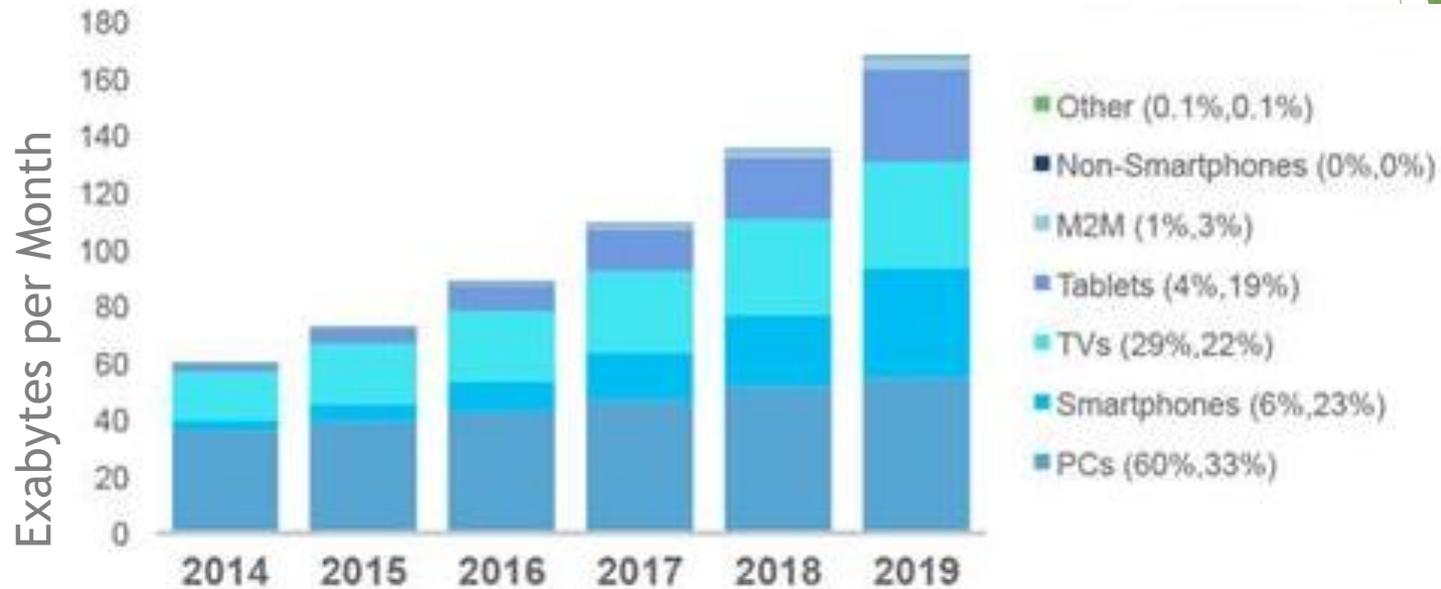
(Eric Schmidt, former CEO of Google)

History of the Internet - Timeline



Source: Malonemediagroup [cited 5.6.2016]

Trends in Global IP Traffic by Device



↓ 27%

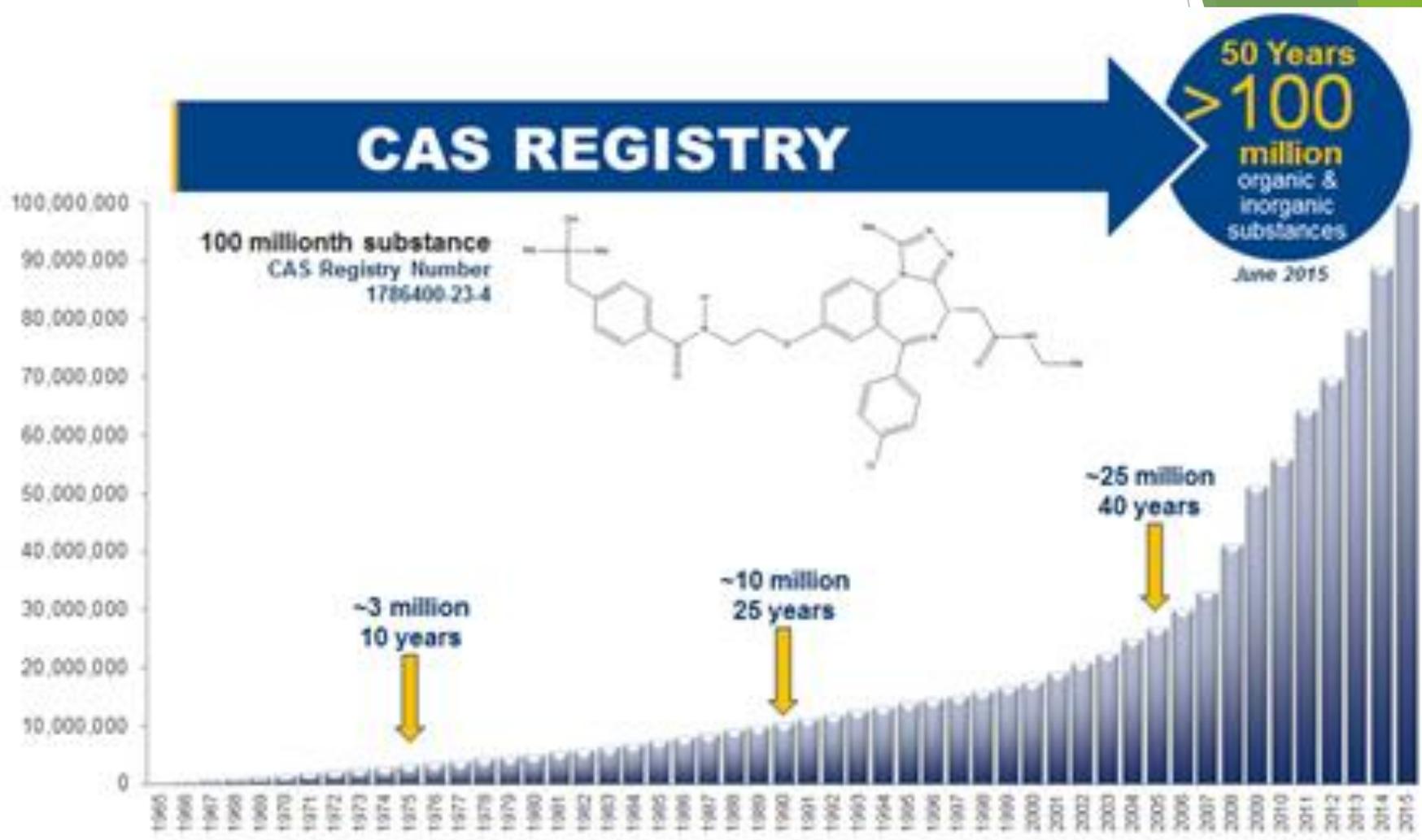


↑ 17%



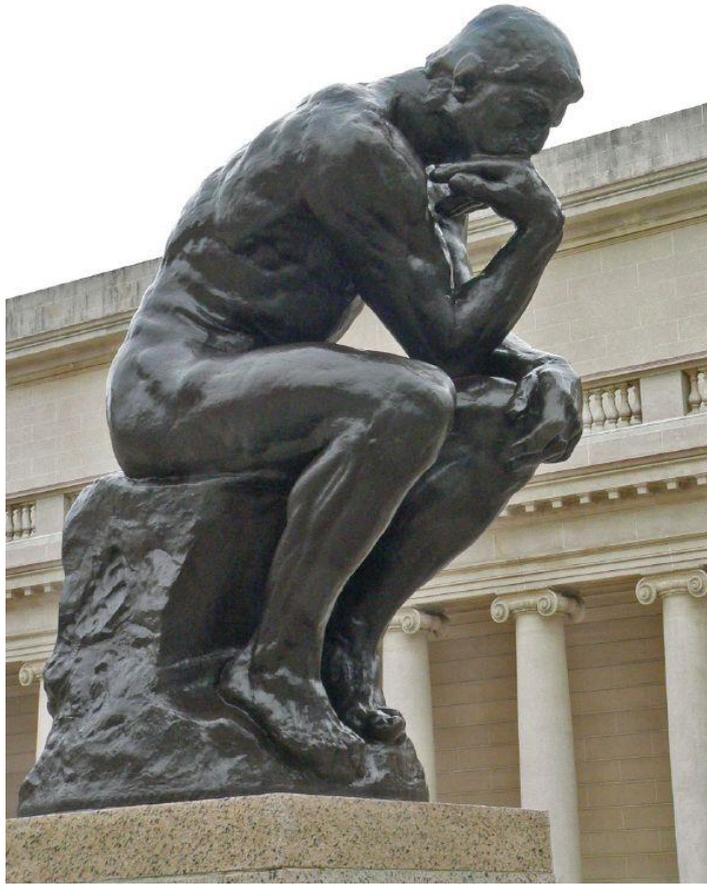
↑ 15%

Exponential Growth of New Compounds



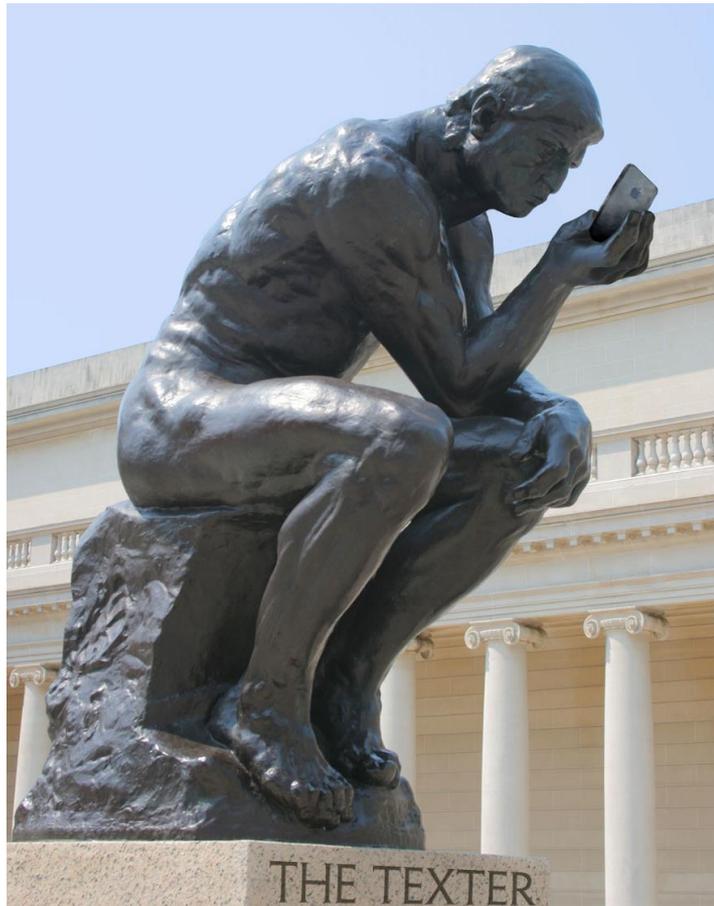
The number of registered compounds in CA Registry
(CAS, 2015)

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

POMEN KEMIJE DANES

KEMIJA, KMETIJSTVO IN PREHRANA

Na prelomu 19. in 20. stoletja so se ljudje običajno prehranjevali s pridelki iz domačega vrta ali z lokalne kmetije, prejšeje stoletje pa je prineslo velkanske spremembe. Za razvite dežele je danes značilno intenzivno kmetovanje z **umetnimi gnojili** in **pesticidi**, s čimer se je proizvodnja hrane precej povečala. Leta 1913 so prvič začeli komercialno proizvajati umetna gnojila, ki so izboljšala donos in proizvodnjo pridelkov.

Kaj so pesticidi?

Uporaba pesticidov odpira danes številna vprašanja. Velik del jih doseže druga mesta, kot smo želeli: poleg raznih vrst organizmov tudi zrak, vodo in kopno. Poleg tega so vse rastline in živali del izredno zapletenih prehranjevalnih verig. V resnici je zapletenih prehranjevalnih verig, ne da bi se prej nemočje zastrupili en organizem, ne da bi se prej nemočje zastrupili en organizem, ne da bi se prej nemočje zastrupili en organizem, ne da bi se prej nemočje zastrupili en organizem. Zaradi teh lastnosti se lahko v organizmih kop širijo preko prehranjevalnih verig.

DDT
DDT (Dikloro-Difenil-Trikloroetan) je eden najbolj znanih sintetičnih pesticidov. Oglejte si model njegove molekule.

Več znanja o DDT

Zdravljenje bolezni živali s cepitjem ali zdravili je bistveno povečalo proizvodnjo hrane. Louis Pasteur je leta 1881 uspešno preprečil bolezen živali proti...

ATOMS IN MOTION

"All things are made of atoms - little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another."

If in some cataclysm, all of scientific knowledge were to be destroyed, and only one sentence passed on to the next generations of creatures, what statement would contain the most information in the fewest words? I believe it is the atomic hypothesis.

RICHARD P. FEYNMAN

i-Pad apps

Interactive e-text books

Aineiden ominaisuuksia

- Aineiden fysikaaliset ja kemialliset ominaisuudet (!)
- Olomuodon muutokset
 - Liukeneminen
 - Happamuus ja emaksisuus
 - Haihtuminen vs kiehuminen



HELSINGIN YLIOPISTON VIIKIN NORMAALIKOULU
1869-2009

Etusivu | Yläkoulun opetus | Lukion opetus | Opetusharjoittelu

Kemian opetus

- Valtakunn. OPS
- Viikin yläkoulun kemian ops
- Viikin lukion ops

Viikin normaalikoulu

- Koulun etusivu
- Wilma, Webmail (HY)
- Connect Pro - kemia, opia

Henkilökohtaiset

- Oma kotisivu

Linkkejä

- OKI
- IS-VET
- Molekyyligastromia

Yhteystiedot

Ari Myllyviita
kemian ja matematiikan lehtori, opettajakouluuttaja
Helsingin Yliopiston Viikin normaalikoulu
Käyntiosoite: Kevätkatu 2, 00790 Helsinki
Postiosoite: PL 30, 00014 Helsingin yliopisto
ari.myllyviita@helsinki.fi
puh: 050 3199 411
skype: myllyviita

Kemian kurssien lähtökohdat

Kemian kurssit noudattavat valtakunnallista opetussuunnitelmaa ja koulun omia opetussuunnitelmia. Kuvassa kemiallisen tasapaino-lyön luokset.

Kemian oppikirjojani: Orbitaali 1, Orbitaali 2, Orbitaali 3, - Tulossa testiin syksyllä 14 Orbitaali 4 ja ehkä Orbitaali 5.

e-Opin Orbitaali-kirjat ovat Suomen ensimmäiset sähköiset kemian oppikirjat ja maailman ensimmäiset muokattavat kemian oppikirjat. Kirjan voi ostaa mm. [täältä](#).

Missä Helsingin yliopiston Viikin normaalikoulu sijaitsee?

Kevätkatu 2

Ajankohtaista

- LaTeX - online versio
- Orbitaali 1 Zine
- Orbitaali 2 Zine -versio
- Peda.net -ympäristö
- Edmodo-oppaali
- Terveystaus -seinä

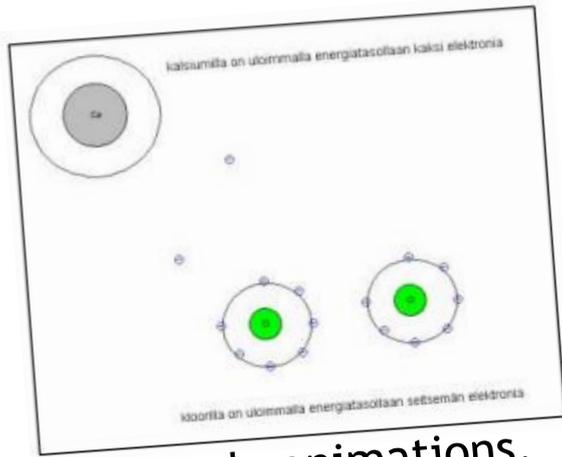
Linkkejä - ATK-ohjelmaa

- Jaksojen järjestelmän ohjelma (engl.)
- Jaksojen järjestelmä (Flash)
- ChemSketch
- Chemium -videot
- Chemistry: All about you
- PhET - Coloradon yliopiston animaatioita
- Vanhat mustat
- Virtuaalinen laboratorio
- WolframAlpha

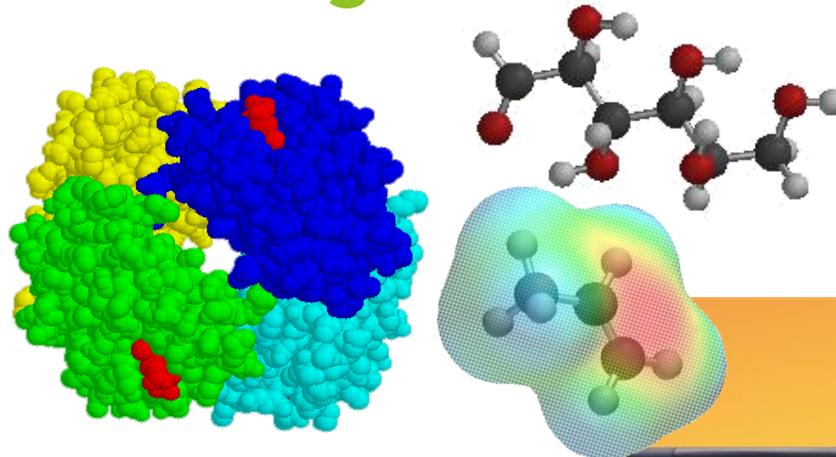
Editable e-notebooks

School web pages

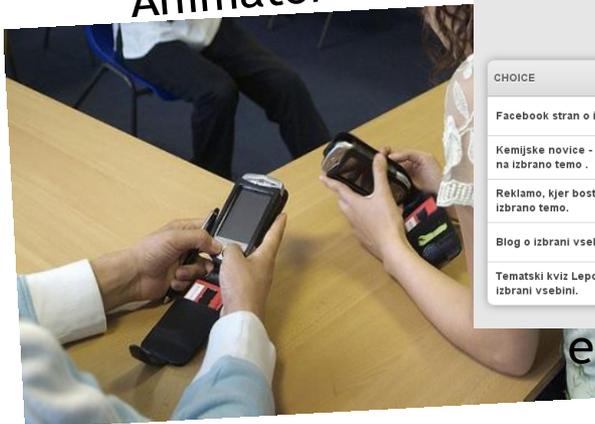
Existing Good Practices of the Use of ICT in Learning Science



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



Molecular modelling



m-learning

Pri projektneem učnem delu boste razvili svoj izdelek. Kakšen izdelek za izbrano temo bi najraje izdelali?

8 responses recorded

CHOICE	VOTES	%
Facebook stran o izbrani vsebini.	0	0%
Kemijske novice - tematski časopis na izbrano temo .	3	38%
Reklamo, kjer boste popularizirali izbrano temo.	2	25%
Blog o izbrani vsebini.	1	13%
Tematski kviz Lepo je biti milijonar o izbrani vsebini.	2	25%

e.g. Response system for educators GoSoapBox



Interactive whiteboards

Existing Good Practices of the Use of ICT in Learning Science



ICT-supported data collection

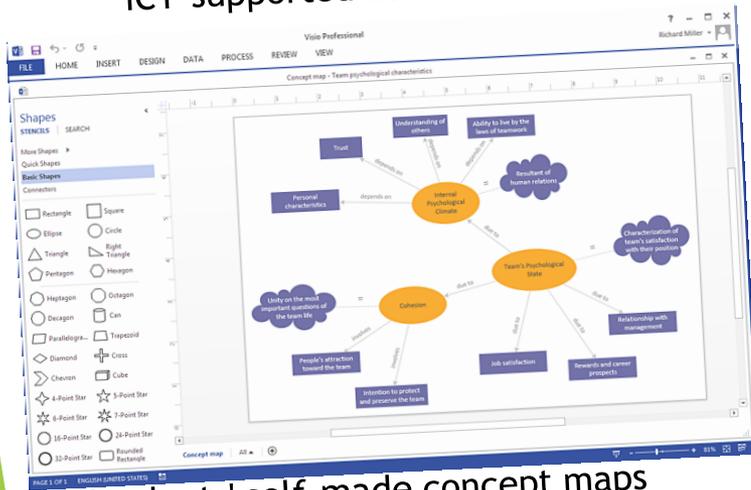
ICT-supported student presentations of project work



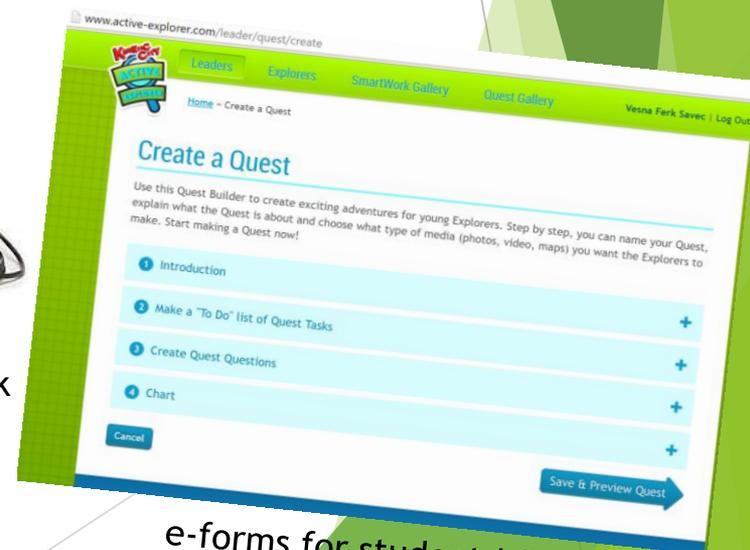
What's the buzz? Comic strips are just one of the many SmartWork projects kids can make with the assets they gather on their smartphone Quests!



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

ucilnica.pef.uni-lj.si/course/view.php?id=487

Spletna učilnica 2015/16 Uporabne povezave Spletna učilnica PeF English (en) Vesna Ferk Savec

@KEMLJUB
Novice za učitelje in ljubitelje kemije

Leto 2014 sta UNESCO in Združene države Amerike razglasili Mednarodno leto kristalografije 2014.

Schneegass, S. (2014). Kristalografija UNESCO.

Kristalografija in mi

MEDNARODNE ŠTUDIJE O NARAVOSLOVJA IN INTERDISCIPLINARNI

Mednarodne študije TIMSS, PIRLS in IEA
Domača mednarodna stran TIMSS, PIRLS in IEA
<http://timssandpirils.bc.edu/>
Rezultati TIMSS 2011 Slovenija
<http://www.pei.si/UserFilesUploads/2012/11/193.2.222.157/UserFilesUploads/193.2.222.157.pdf>
V pričakovanju rezultatov TIMSS 2011

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

Admin Coming Soon: A Brand New Admin Experience!

Lakemans

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

Käyttätymistieteellinen tiedekunta / Ari Myllyviita

Editable e-books

Myllyviita, Ari

Tehtävät ja kokeellisuus

Perustiedot

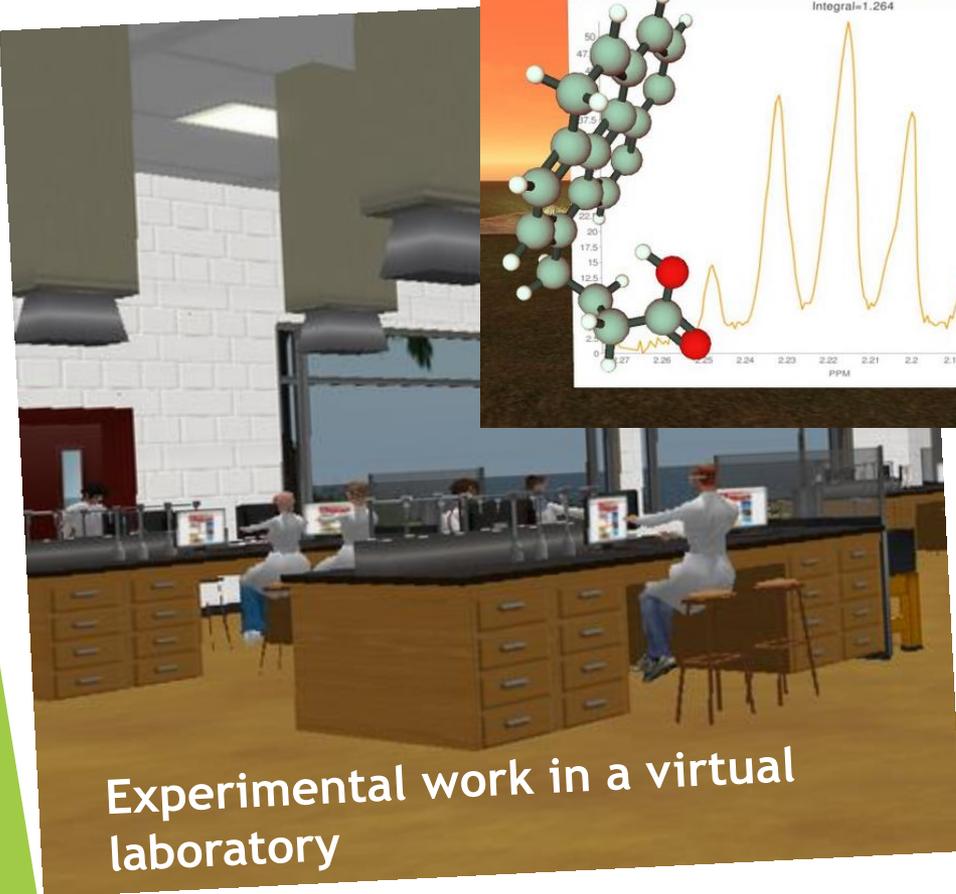
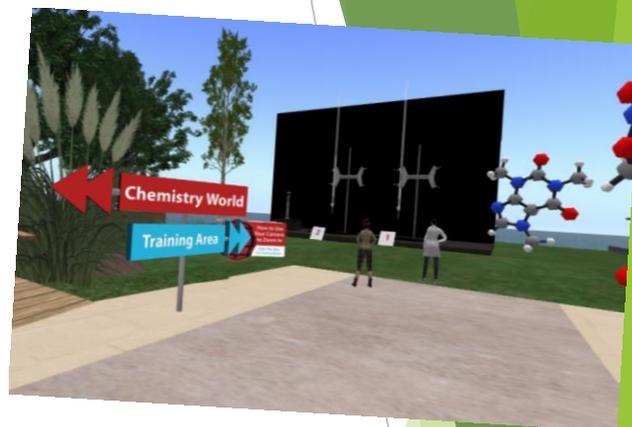
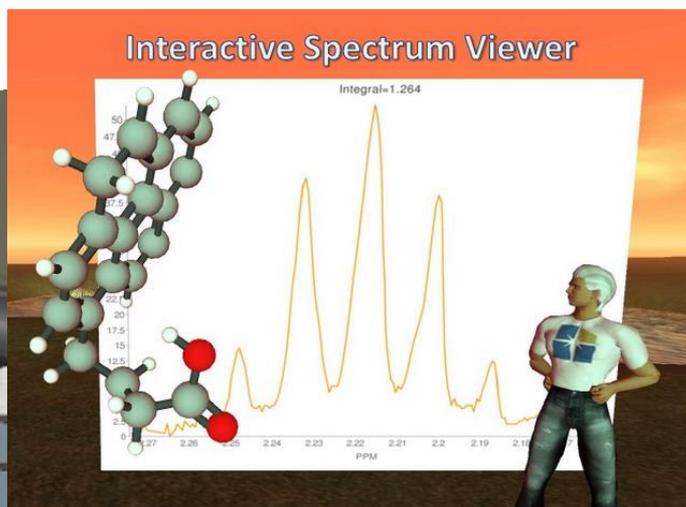
2.2 Jaksollisesta järjestelmästä saatava tieto

www.helsinki.fi/yliopisto

<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

Home About Search Twitter

TWEETS 717 FOLLOWING 134 FOLLOWERS 98 LIKES 28

KEMLJUB
@Kemljub
Kemljub je twitter račun za vse učitelje in ljubitelje kemije.
Joined September 2012

10 Photos and videos

Retweeted by @ChemistryWorld
Chemistry World @ChemistryWorld · May 5
Smallest ever molecular thermometer made from fluorescent probes
rsc.li/1UB8c7r

Retweeted by @ChemistryWorld
Chemistry World @ChemistryWorld · May 5
Even when politics is a barrier, scientists perseve collaborations
rsc.li/26WcXxk

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

Social media and mentoring (ICT-group)

Tieto- ja viestintätekniikka opetuksessa/ICT in Education

Art Etsi uusia jäseniä

Tieto- ja viestintätekniikka o... Jäsenet Tapailut Kuvat Tiedot

Kirjota julkaisu Lisää kuva/video Kysy Lisää tiedosto

Kirjota jotain...

KEMMITYTÄ JÄSENIÄ

Kaisa Vähäyppä
5 samankuuta · Muokkaa

Oheisa vielä muistutuksena tämän ryhmän perustarkoituks. Ptäydytään siinä, aihe on riittävän laaja. Muille teemoille on lukuisia muita foorumeita. Linkkejä, ideoita ja keskustelua tieto- ja viestintätekniikan opetus- ja oppimiskäytöstä Suomessa ja kansainvälisesti. Suomeksi, ruotsiksi ja englanniksi. Keskustelua kaikilla opetuksen asteilla varhaiskasvatuksesta korkeakouluhin.

Työssä Kommentoi Jaa 54 13

VIERAILEVAJEN TOIMINTA

Anja Kareinen
7 joulukuuta

Mnulla on Workshop ITK:sa Hämeenlinnassa huhtikuussa. Aiheena ohjelmointi yläkoukussa ja lukiossa Processing-kielillä. Tekemäni materiaali ohjaa pelin tai animaation tekemiseen. Esitellen myös muita mahdollisuuksia.

Esimerkinä neijä tehtävää

Tehtävä... Näytä lisää

Työssä Kommentoi Jaa

Mikko Jordman ja 2 muuta tykkäivät tästä.

Kirjota kommentti...

TIETOJA 12 834 jäsentä

Yh. Julkinen ryhmä

Linkkejä, ideoita ja keskustelua tieto- ja viestintätekniikan opetuskäytöstä Suomessa ja kansainv... Näytä lisää

12 834 jäsentä (261 uutta) Kutsu sähköpostitse

Lisää avoimia ryhmiä

LUO UUSIA RYHMIÄ

Ryhmien analysoi jakaminen kavereille, peitejäsenille ja sinun jäsenille on helpompaa kuin koskaan.

Luo ryhmä

SUOSITELLUT RYHMÄT Näytä kaikki

FB-ryhmien ylläpitäjät
Kaisa Vähäyppä ja 4 muuta kavereita löytyivät

Lisä

Peruskasvatteiden verkosto
Riitta Jukka Somunen ja 4 muuta kavereita löytyivät

Lisä

Ennenkoiden
Anne Rongas ja 4 muuta kavereita löytyivät

Lisä

Skopsin ry
Anu Linunen ja 4 muuta kavereita löytyivät

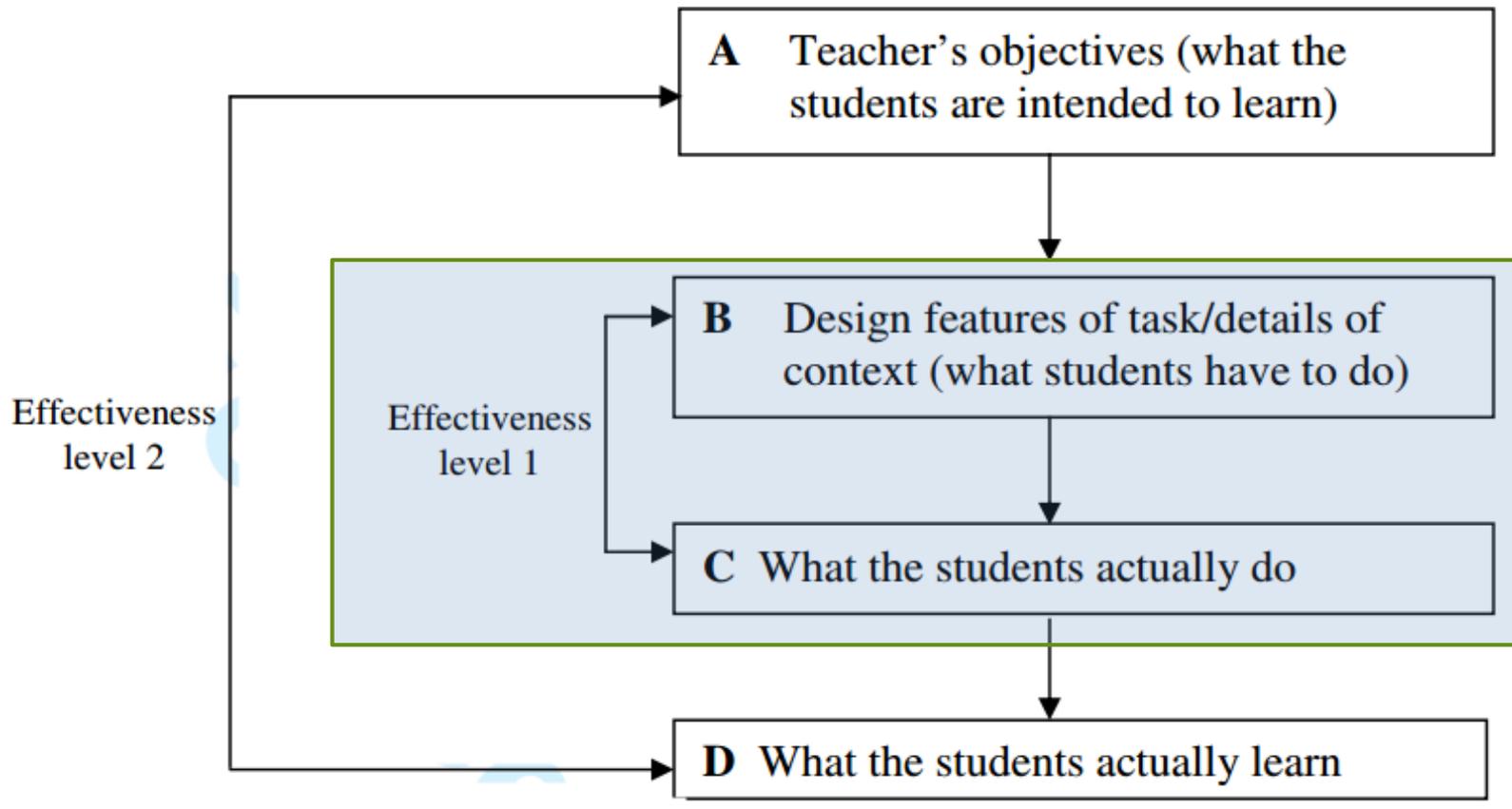
<http://www.myllyviita.fi/> [cited 5.6.2016]

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?

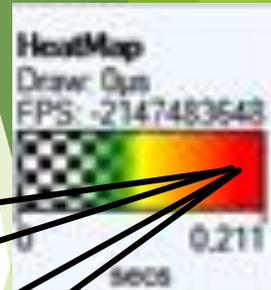
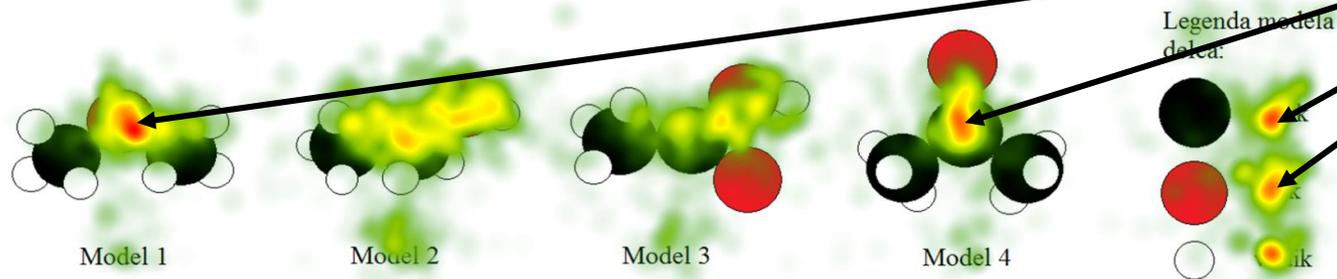
Students using laptops in taking notes :

- ▶ 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*)

Slika prikazuje modele različnih organskih spojin. Kateri model ponazarja molekulo alkohola?



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

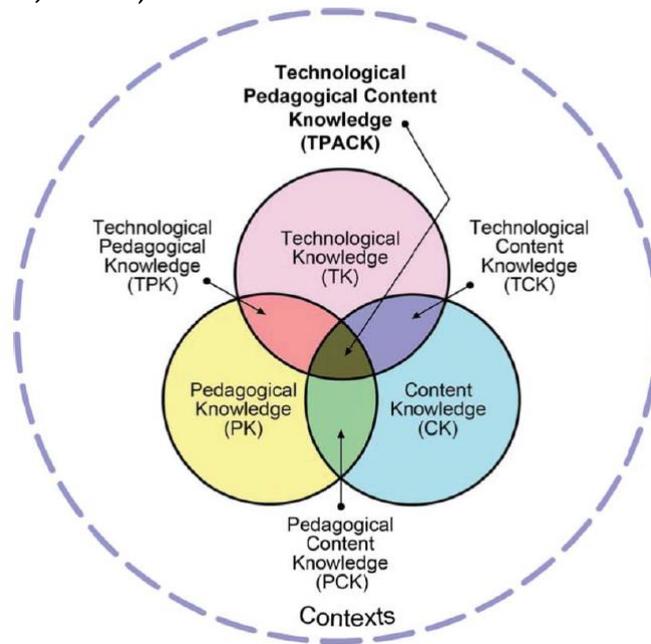
- ▶ Teachers' **professional development** is the key for successful integration of ICT at school level (Ertmer & Ottenbreit-Leftwich, 2010; Clarks & Hollingsworth, 2002; Perna & Aksela, 2009),
- ▶ Teachers' participation in **subject-specific ICT training** increased ICT integration in the classroom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

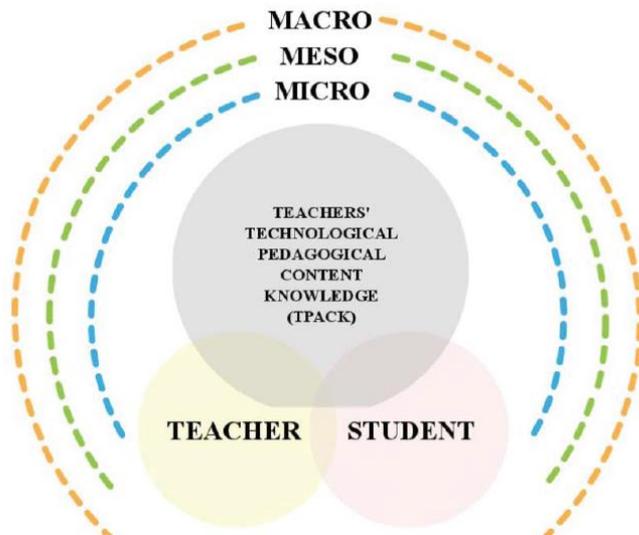


Conceptual Framework for Context

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