What All Teachers Should Know About Informatics

ISSEP 2022
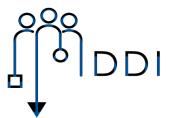
Prof. Dr. Torsten Brinda
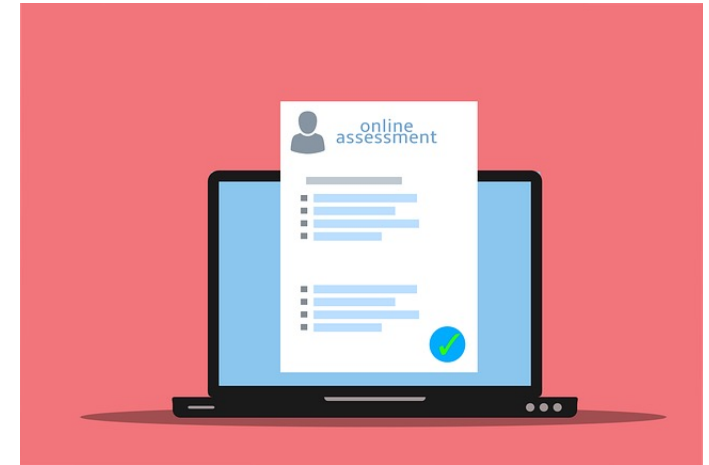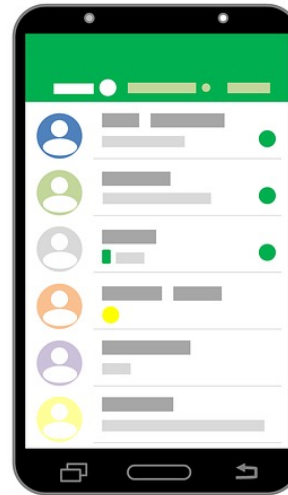
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Informatics has changed and is still changing our everyday lives

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WhatsApp

DigComp 2.1

The Digital Competence Framework for Citizens

With eight proficiency levels and examples of use

Online Shopping

DDI

informatics for all

torsten.brinda@

Where do schoolteachers find Informatics in their everyday lives?

| Name	Surname	Grade	Contact	Phone	Mail	Remark
Albright	Amalia	7	Anna (M)	0201/123	aa@gmail.com	
Baker	Bridget	7	Barack (F)	0201/456	bb@mail.com	
Clover	Charlie	8	Ben Miller (F)	0201/789	bm@aol.com	Diabetes
...	...	...	...	...	...	...

Agenda

Which digitalization-related competencies do all schoolteachers need?
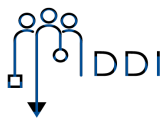
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Which Informatics competencies do all schoolteachers need?

→

How can Informatics competencies be included in teacher education?
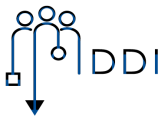
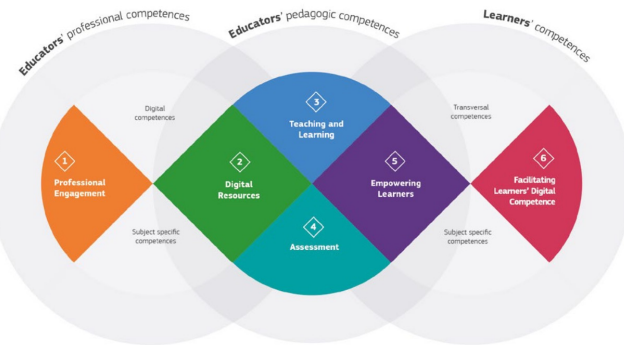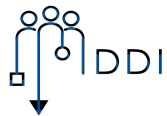# Which digitalization-related competencies do all schoolteachers need?

torsten.brinda@uni-due.de

Models (I): Learning and teaching with digital media

KMK strategy
(KMK, 2016)
(KMK - Standing
Conference of the
Ministers of Education
and Cultural Affairs)

Media
competence
framework
(Medienberatung
NRW, 2018)

DigCompEdu
(Redecker, 2017)

Orientation
framework
(Eickelmann,
2020)

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Models (II): Informatics standards
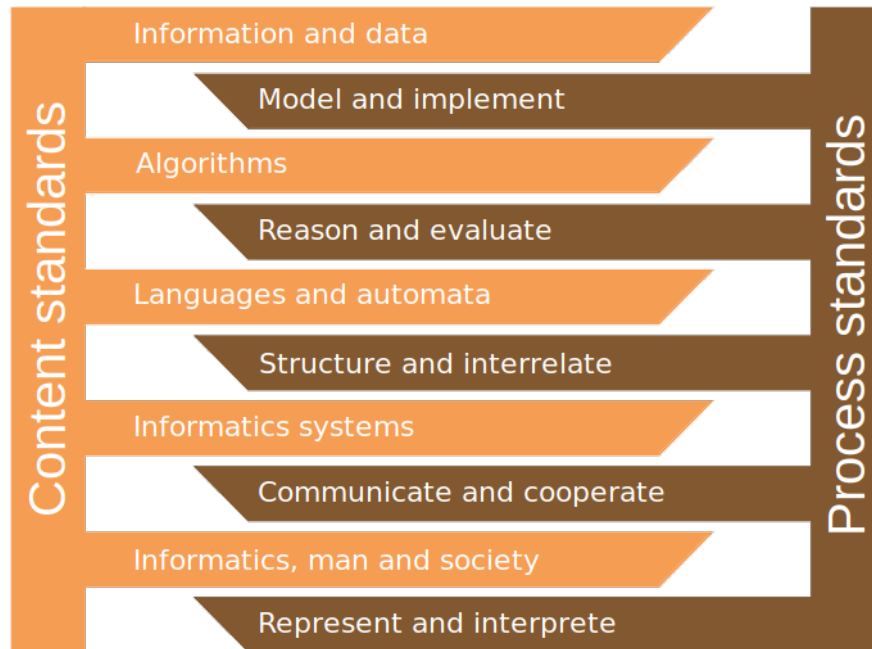
Recommendations for Educational Standards in Informatics (GI)
www.informatikstandards.de
(Lower sec.: 2008, Upper sec.: 2016, Primary: 2019)

The K–12 Computer Science Framework
(www.k12cs.org, K–12 Computer Science Framework
Steering Committee, 2016)

Models (III): TPACK and FITness

DidL
Digitalisierung in der
Lehramtsausbildung
UDE

Technological
Pedagogical Content
Knowledge
(TPACK)

Technological
Pedagogical
Knowledge
(TPK)

Technological
Knowledge
(TK)

Technological
Content
Knowledge
(TCK)

Pedagogical
Knowledge
(PK)

Content
Knowledge
(CK)

Pedagogical
Content
Knowledge
(PCK)

Contexts

Koehler &
Mishra (2009)

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Intellectual Capabilities

1. Engage in sustained reasoning;
2. Manage complexity;
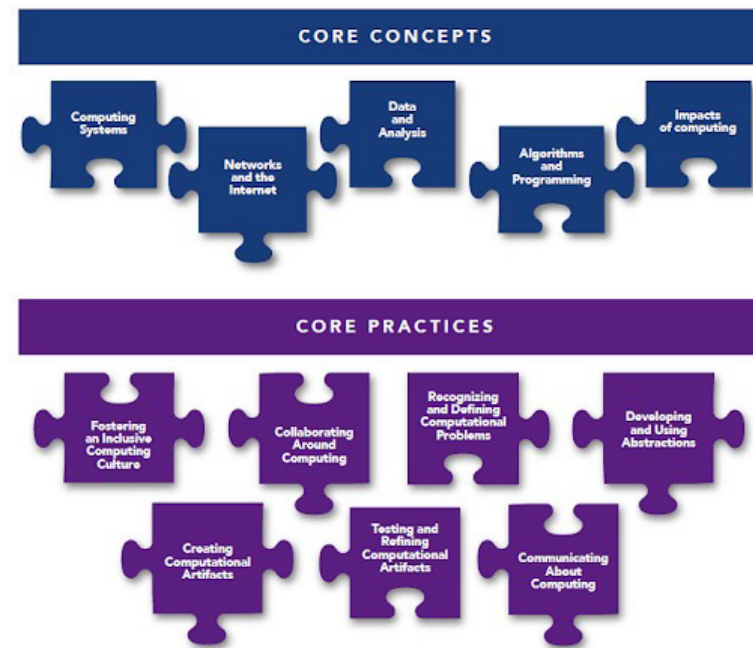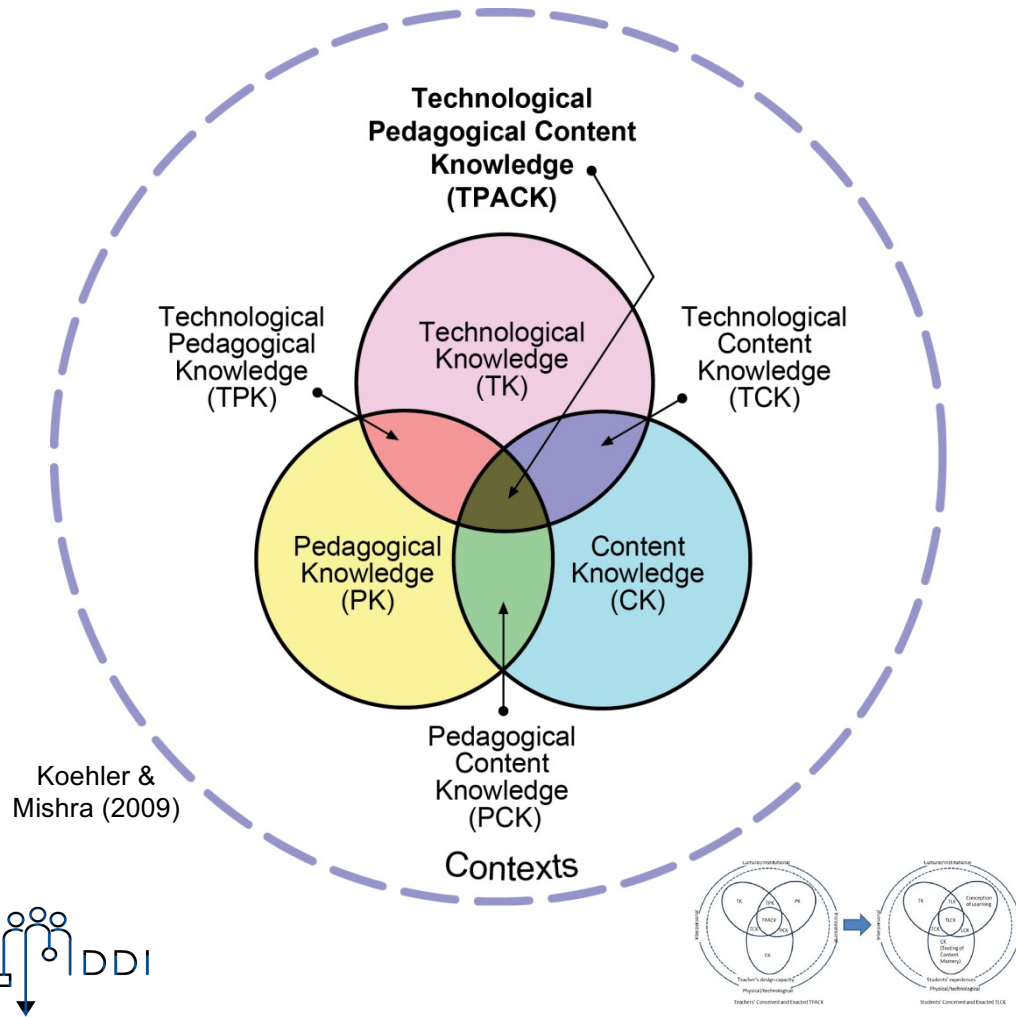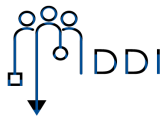3. Test a solution;
4. Manage problems in faulty solutions;
5. Organize and navigate information structures and evaluate information;
6. Collaborate;
7. Communicate to other audiences;
8. Expect the unexpected;
9. Anticipate changing technologies; and
10. Think about information technology abstractly.

Information Technology Concepts

1. Computers;
2. Information systems;
3. Networks;
4. Digital representation of information;
5. Information organization;
6. Modeling and abstraction;
7. Algorithmic thinking and programming;
8. Universality;
9. Limitations of information technology; and
10. Societal impact of information and information technology.

Information Technology Skills

1. Setting up a personal computer;
2. Using basic operating system features;
3. Using a word processor to create a text document;
4. Using a graphics and/or artwork package to create illustrations, slides, or other image-based expressions of ideas;
5. Connecting a computer to a network;
6. Using the Internet to find information and resources;
7. Using a computer to communicate with others;
8. Using a spreadsheet to model simple processes or financial tables;
9. Using a database system to set up and access useful information; and
10. Using instructional materials to learn how to use new applications or features.

3. "Digitalization-Related Competences"

2. "Informatics concepts"
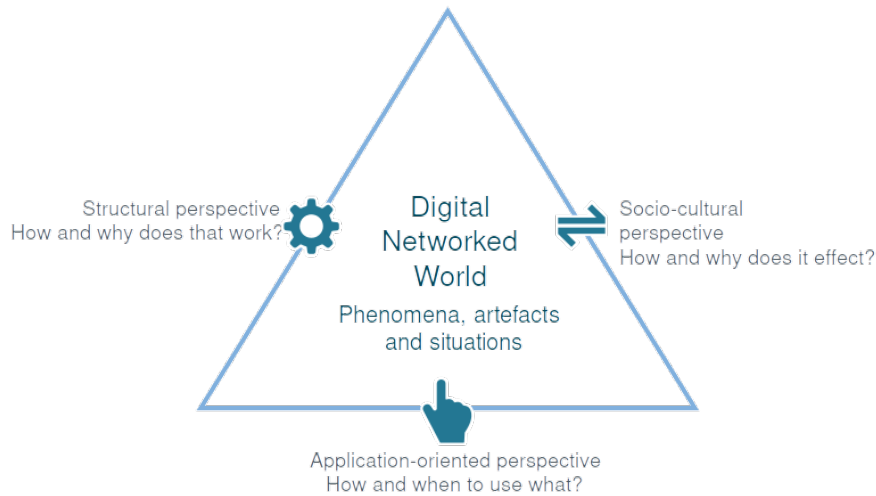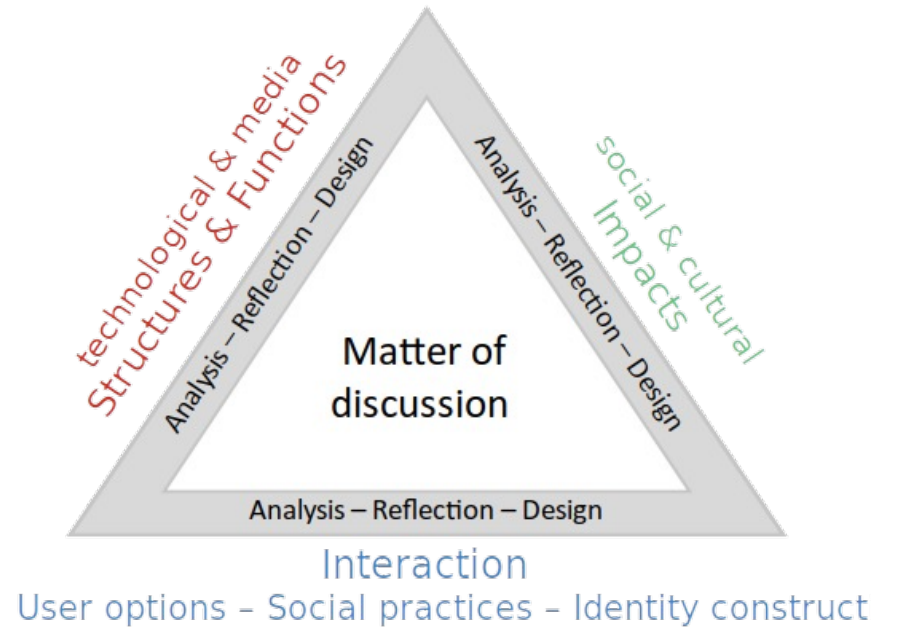
But: Gaps!

1. "Media usage"

FITness (Fluency with
Information Technologies, 1999)
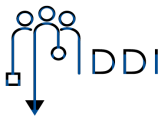
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Models (IV): Dagstuhl triangle and Frankfurt triangle

Dagstuhl triangle (2016)

Frankfurt triangle (2019)

Combining the models

Decisions
- Competences instead of knowledge areas
- Digitalization instead of technology

K12CS (ACM et al. 2016)

Subject-specific education in the digital world (GFD 2018)

...

Fluency with IT (NRC 1999)

Informatics standards (GI 2008, 2016, 2019)

...

MKR NRW (Medienberatung NRW 2018)

Frankfurt triangle (Brinda et al. 2020)

Digitalization-related competences

Competences regarding (teaching with and about) digital technologies in a subject

KMK-Standards for subjects (KMK 2019a)

Subject-related competences

...

DigComp (Ferrari 2013)

Education in the digital world (KMK 2016)

...

TPACK-Modell (Koehler/ Mishra 2009)

Competences regarding teaching with and about digital technologies (in a subject)

Pedagogical content-specific competences (regarding digital technologies)

KMK-Standards Fachdidaktik (KMK 2019a)

...

DigComp-Edu (Redecker 2017)

...

Pedagogical competences

Orientierungsrahmen NRW (Eickelmann et al. 2020)

KMK-Standards Bildungswissenschaften (KMK 2019b)

...

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Combining the models

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Teachers' **digitalization-related competencies**

DidL Digitalisierung in der Lehramtsausbildung **UDE**

TEACHERS' D... ...PETENCIES

DigCompEdu Orientation framework NRW

DigCompEdu Orientation framework NRW

CRITICAL-CONSTRUCTIVE PRACTICE AND ITS REFLECTION (C)

TEACHING AND LEARNING (B.1)
- **Lesson Planning**
- **Teaching Methods, Processes and Learner Activities**
- **Assessment, Evaluation and Revision**

PROFESSIONAL ENGAGEMENT (B...)
- **Institutional Development**
- **Cooperation**
- **Lifelong Learning**

Subject-specific, interdisciplinary and transdisciplinary competencies for teaching with and about digital technologies

Fostering learners' subject-specific and digitalization-related competencies

Subject-specific, interdisciplinary and transdisciplinary competencies for school and professional development in the digital world

Cultural/ institutional context

Demand for development-related competences

Interpersonal context

"Understanding the world" + Ability to create

Physical/techno-logical context

Demand for development-related competences

Intrapersonal context

Funktional application, Integration into social practices, shaping of own identity

Subject-specific, transdisciplinary and interdisciplinary basic competencies for handling digital technologies (analysis, reflection, identity construction) (A):

Technological and media structures and functions (A.1)

Social and cultural impact (A.2)

Interaction: user options, social practices, agency (A.3)

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Borukhovich-Weis et al. 2022, p. 8

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Which Informatics Competencies do All School Teachers Need?

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Perception of digitalization and education in Germany

- Public discourse focuses on technology (tablets, missing wifi) or isolated aspects (privacy laws)

- Many „silver bullet" promises in the past

- Rejecting attitude against everything digital

- Overestimation of „digital natives"

- Schools lack of infrastructure (still)

- Teachers lack(ed) of digital competences

- Authorities lack(ed) of willingness to act (and competence as well)
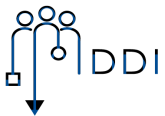
Work of the German Informatics association (GI) in the area of education
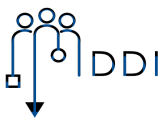
- Educational recommendations:
  - For lower secondary education (2008)
  - For upper secondary education (2016)
  - For primary education (2019)
  - Together with the German STEM community: Informatics reference framework (GeRRI, 2020)

- Informatik-Monitor:
 - Monitors the state of Informatics education in lower secondary education in Germany's federal states

Process standards

Information and data
Model and implement
Algorithms
Reason and evaluate
Languages and automata
Structure and interrelate
Informatics systems
Communicate and cooperate
Informatics, man, and society
Represent and interpret

Content standards

www.informatikstandards.de

GESELLSCHAFT FÜR INFORMATIK E. V. (GI)
INFORMATIK-MONITOR
SEPTEMBER 2022
WWW.GI.DE

www.informatik-monitor.de

GeRRI: https://www.mnu.de/blog/595-gerri-gemeinsamer-referenzrahmen-informatik

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Possible approach: Orientation along Informatics competency frameworks
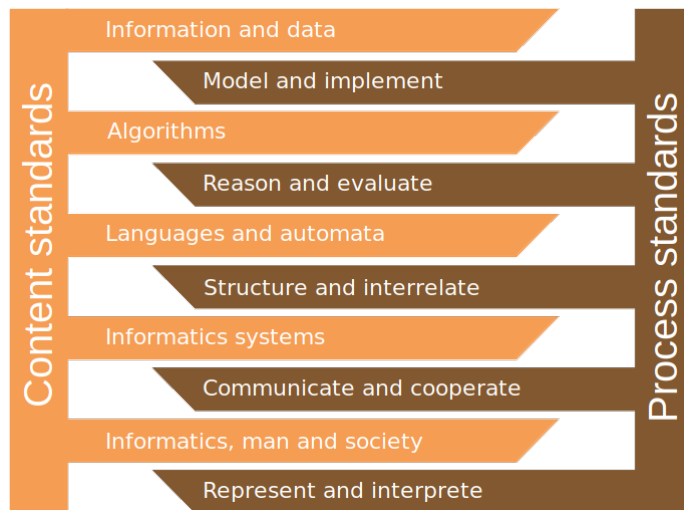

Recommendations for Educational Standards of Informatics (GI)
www.informatikstandards.de
(Lower sec.: 2008, Higher sec.: 2016, Primary: 2019)

- Advantage(s):
  - do already exist
  - widely accepted in the community
- Disadvantage:
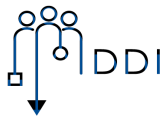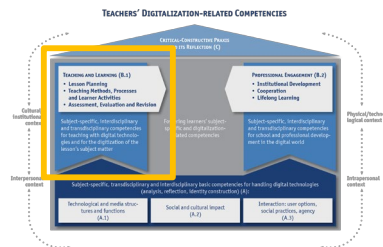 - convincing for educators and/or politicians, i. e. people who decide educational politics?
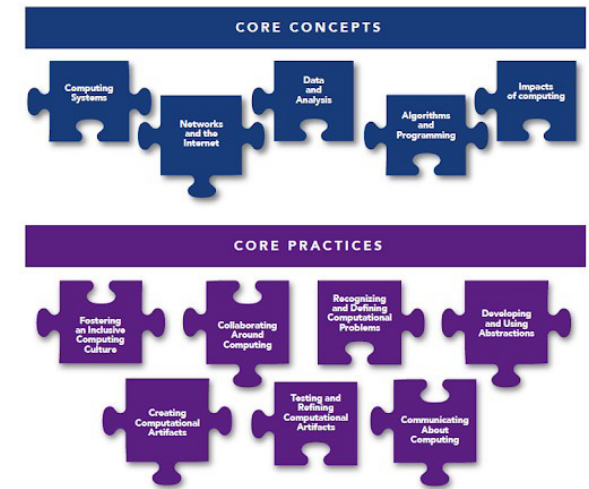
The K–12 Computer Science Framework
(www.k12cs.org, K–12 Computer Science
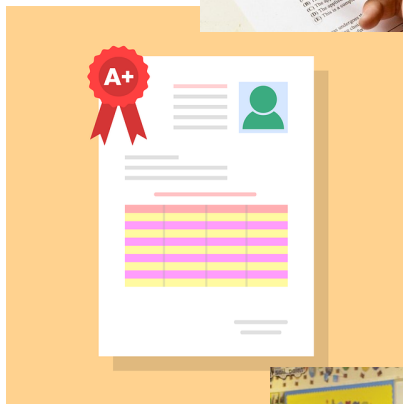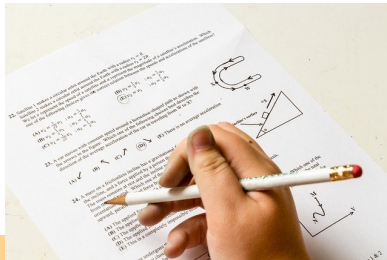Framework Steering Committee, 2016)
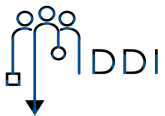
Possible approach: Orientation along topics of other subject groups / scientific fields
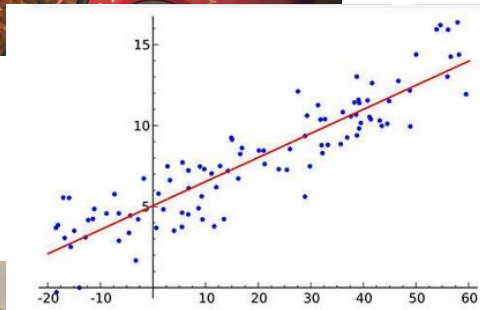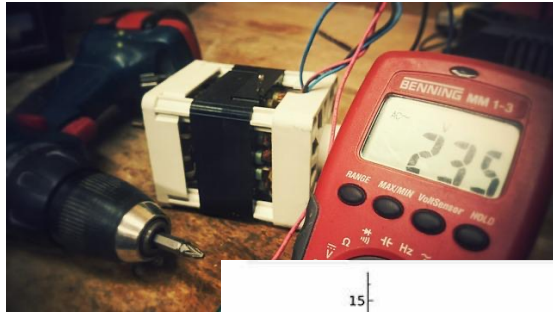

- Advantage(s):
  - necessity obvious
  - no transfer from concept to an application to be made
- Disadvantage:
  - different strategies for every scientific field (science, social sciences, languages, etc.) needed

Possible approach: Orientation along profession-and-digitalization-related activities of all teachers

- Advantage(s):
  - o necessity obvious
  - o no transfer from concept to an application to be made
  - o fits for all teachers
- Disadvantage:
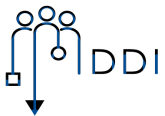 - o is not (always) directly applicable as a topic in lessons
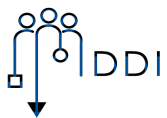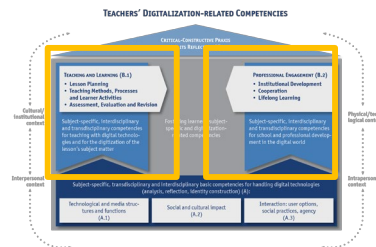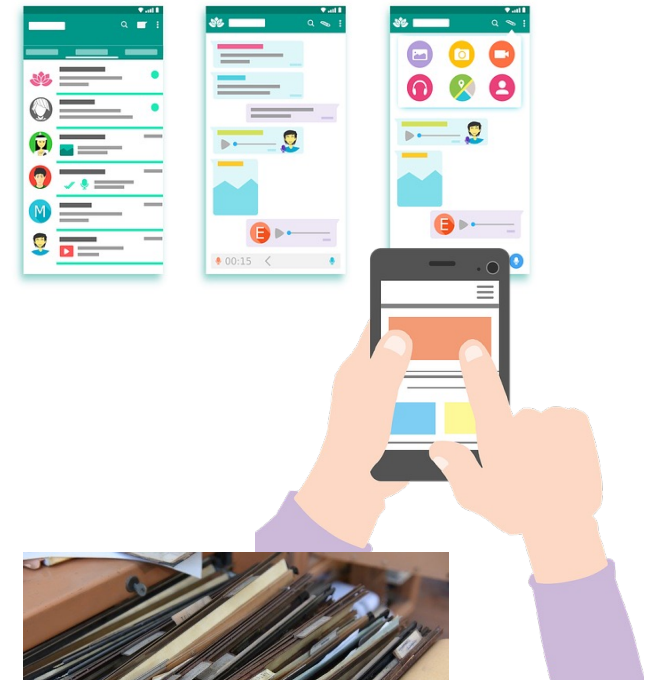
Goal: recommendations for Informatics for all teachers

(Selected) Objectives:

- Teachers recognize digitization-related changes and Informatics structures in their own subjects, related sciences and in the field of education.

- Teachers show an open and informed attitude towards phenomena in the digital world.

- Teachers can reflectively select digital tools and informatics methods in their everyday professional lives and use them competently in a structured, confident and efficient manner.

- Teachers can consciously link phenomena to Informatics concepts to explain and reflect on them.

- Teachers' own problem-solving approach to data and IT is exemplary and enables students to adopt an Informatics perspective and to act competently.

- Teachers take an informatics perspective into account while enhancing their own school and their own professional development.

Goals published as a common position (in German, April 2021)

https://ak-lk-bildung.gi.de

Background: Structure of teacher education in Germany

- Three phases of teacher education:
    1. Preparation in teaching-degree study programs at university (5 years)
    2. Preparation as a trainee teacher in school (1.5 to 2 years)
    3. In-service teacher training (lifelong learning)

- German Ministries of Education (KMK) agree on common standards for teacher education for the subjects and educational sciences

    o KMK publishes these standards for all 16 federal states for the first two phases

    o Standards are the basis for accreditation of study programs

- Every teacher studies two (to three) subjects and educational sciences

Official standards for teacher education in Germany

- Four areas of expertise:
  - Teaching
  - Educating
  - Advising and assessing
  - Innovating

- Last update (2019) for Educational Sciences contains many competences with a relation to Informatics in these areas

- Formulation of competences is very general, needs interpretation

KMK
KULTUSMINISTER
KONFERENZ

Standards für die Lehrerbildung:

Bildungswissenschaften

(Beschluss der Kultusministerkonferenz vom 16.12.2004 i. d. F. vom 16.05.2019)

SEKRETARIAT DER KULTUSMINISTERKONFERENZ
BERLIN · Taubenstraße 10 · 10117 Berlin · Postfach 11 03 42 · 10833 Berlin · Telefon +49 30 25418-499
BONN · Graurheindorfer Straße 157 · 53117 Bonn · Postfach 22 40 · 53012 Bonn · Telefon +49 228 501-0

https://www.kmk.org/fileadmin/Dateien/veroeffentlichungen_beschluesse/
2004/2004_12_16-Standards-Lehrerbildung-Bildungswissenschaften.pdf
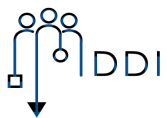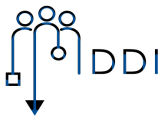
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Towards Informatics competencies for all teachers

1. Official KMK standards for teacher education as a starting point

2. Description of example situations taken from the four areas of competence
   o Teaching
   o Educating
   o Advising and assessing
   o Innovating

   Description of typical profession-related situations of a fictitious teacher (named "Kim")

3. Elaboration of the required Informatics knowledge and competences

4. Collection of references to Informatics concepts and competency areas of existing recommendations
   o GI standards
   o Informatics reference framework – GeRRI

Example: Competence area "Assessing"

Competency 8 (see: KMK 2019, p. 12, in German):
"Teachers capture students' performance development and assess learning processes and performance on the basis of transparent assessment standards."
Required sub-competency(ies):
Teachers "know different forms and effects of performance assessment and feedback, their functions and their advantages and disadvantages." They "know potentials and limitations of technology-based tasks and examination formats." They "make reflective use of digital options to support performance recording, assessment and evaluation."

Example situation of Kim

Example situation from Kim's school	A correspondingly informatically competent teacher ...
For the evaluation of learning outcome assessments, Kim selects (possibly digital) tools with regard to their advantages and disadvantages in terms of availability, usability, the competencies to be assessed, and the resulting outcome format. Kim responsibly assesses opportunities and risks. The data is consistently stored on encrypted media and deleted at the end of the school year.	- KNOWS licensing models in order TO BE ABLE to assess which programs can and may be used and are helpful for their daily school life. - KNOWS the basic structure of programs, the difference between data and information, and the limitations of computing systems in order to BE ABLE to evaluate the output of processed data and relate it to other observations. - KNOWS the operation and the associated opportunities and dangers of local and networked data management TO BE ABLE to select suitable tools. - …

Addressed Informatics concepts competence areas
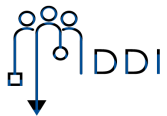
Addressed Informatics concepts	Addressed areas of the GI standards (2008)	Addressed areas of the GeRRI (2020)
• Algorithms • Licensing models for software, open source • Data and information • Computer networks • Data protection • Privacy of personal information • Data security	C: Information and data C: Algorithms C: Informatics and Society C: computing systems P: Representing and interpreting P: Reasoning and evaluating	• Digitization (coding, personal data) • Computing systems (structure, networks, Internet usage, security, socio-technical context) • Automatization (algorithms)

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Consequences

- All teachers should possess at least the same Informatics competencies as school students by the end of secondary school.

- They also need some didactical and pedagogical competences to address selected Informatics concepts in their subjects.

- Several courses shall be related to Informatics competences (also in the denominations).

- Special course(s) of at least 5 ECTS should be explicitly dedicated to Informatics competencies and concepts.

- All university personnel teaching in teacher education – at least in educational sciences and subject didactics – should also possess at least the competencies recommended here for students.

Process standards

- Information and data
- Model and implement
- Algorithms
- Reason and evaluate
- Languages and automata
- Structure and interrelate
- Informatics systems
- Communicate and cooperate
- Informatics, man, and society
- Represent and interpret

Content standards

How can Informatics competencies be included in teacher education?

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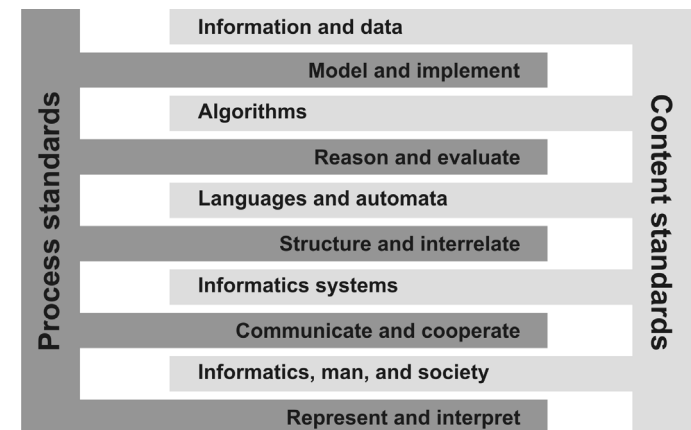
How can digitalization-related competencies be included in teacher education?
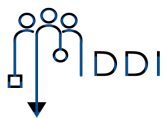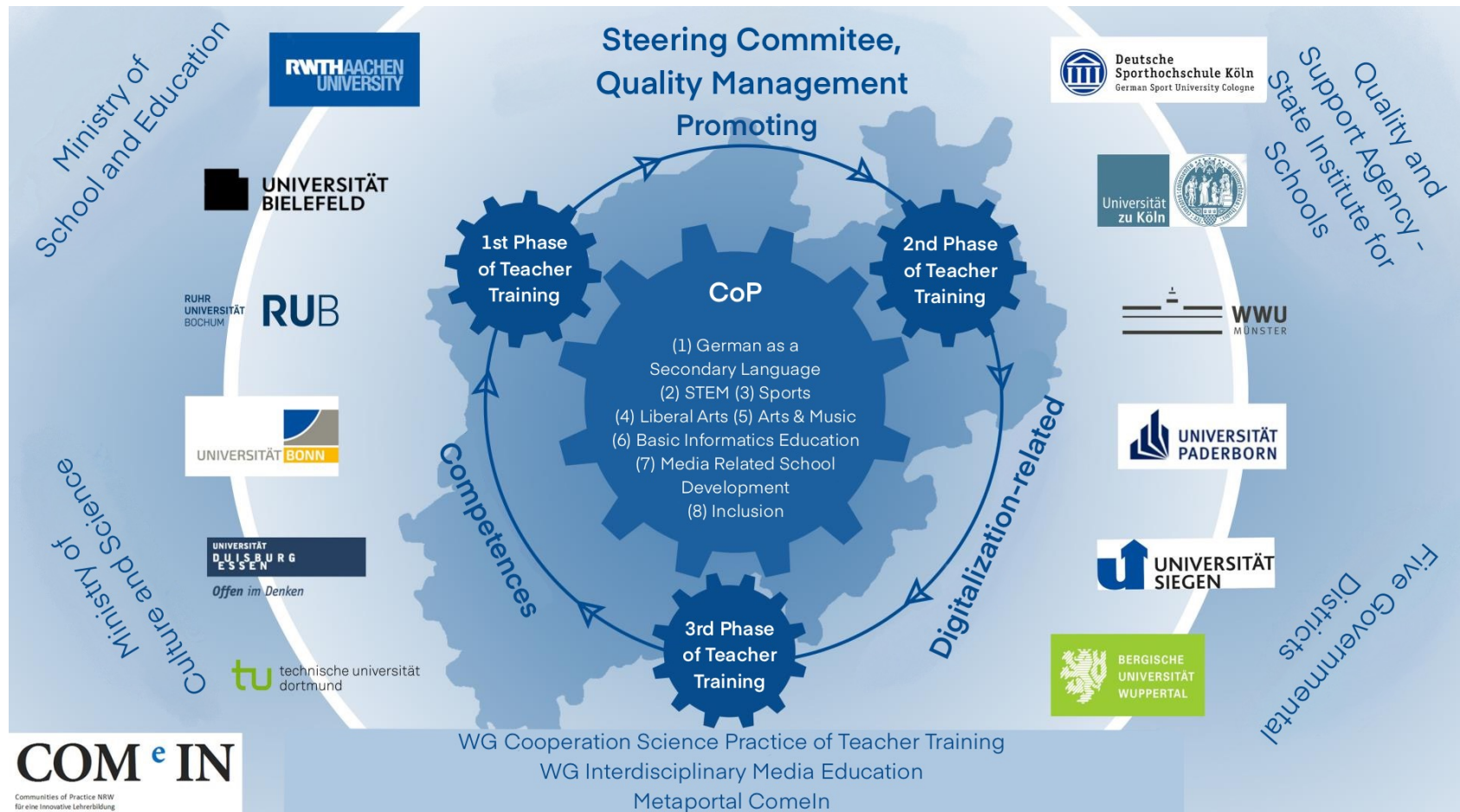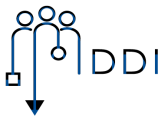
The CoP Approach – How to include Informatics education in general teacher education?
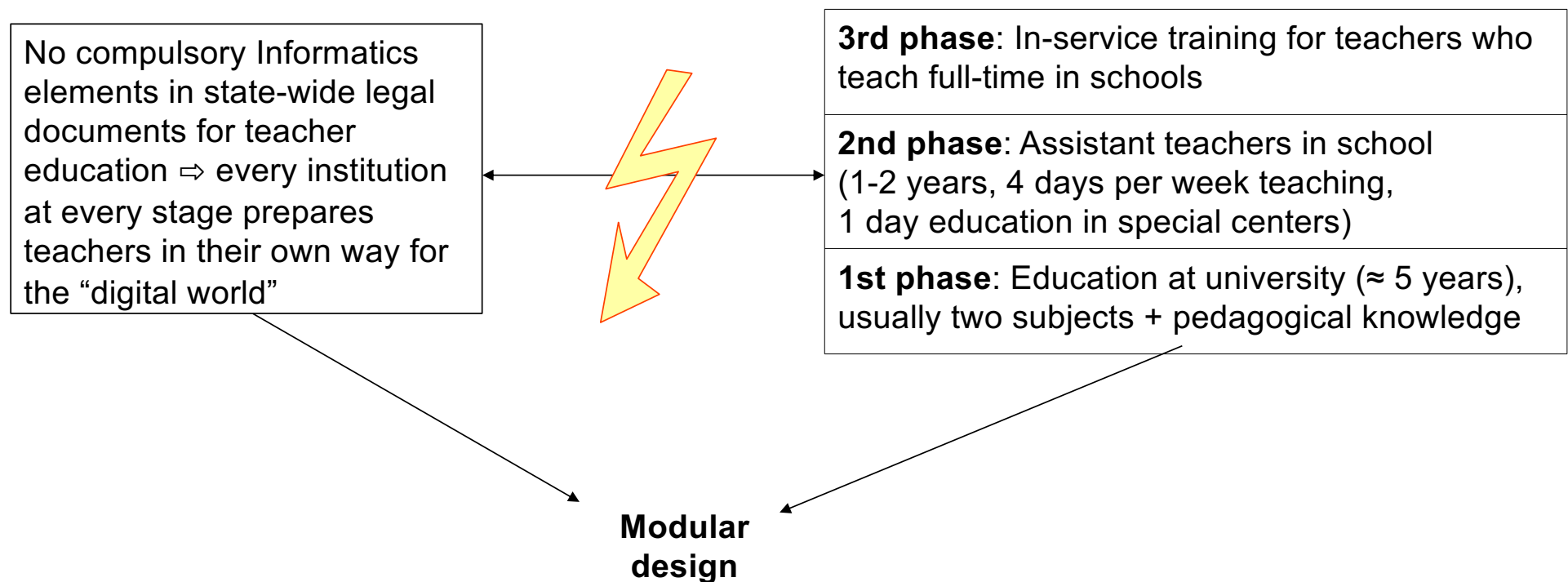
No compulsory Informatics elements in state-wide legal documents for teacher education ⇨ every institution at every stage prepares teachers in their own way for the "digital world"

3rd phase: In-service training for teachers who teach full-time in schools

2nd phase: Assistant teachers in school (1-2 years, 4 days per week teaching, 1 day education in special centers)

1st phase: Education at university (≈ 5 years), usually two subjects + pedagogical knowledge

Modular design

The CoP Approach – How to include Informatics education in general teacher education?

Creation of modular units, that are largely independent of each other and can be used in all phases of teacher education

Example phase 1
A rather small seminar is constructed from four possible modules

The CoP Approach – How to include Informatics education in general teacher education?

Creation of modular units, that are largely independent of each other and can be used in all stages of teacher education

Example phase 1
A larger lecture is constructed from all modules

The CoP Approach – How to include Informatics education in general teacher education?

Creation of modular units, that are largely independent of each other and can be used in all stages of teacher education

1 2 3 4 5 6 7 8 … n

Example phase 1
A seminar is constructed
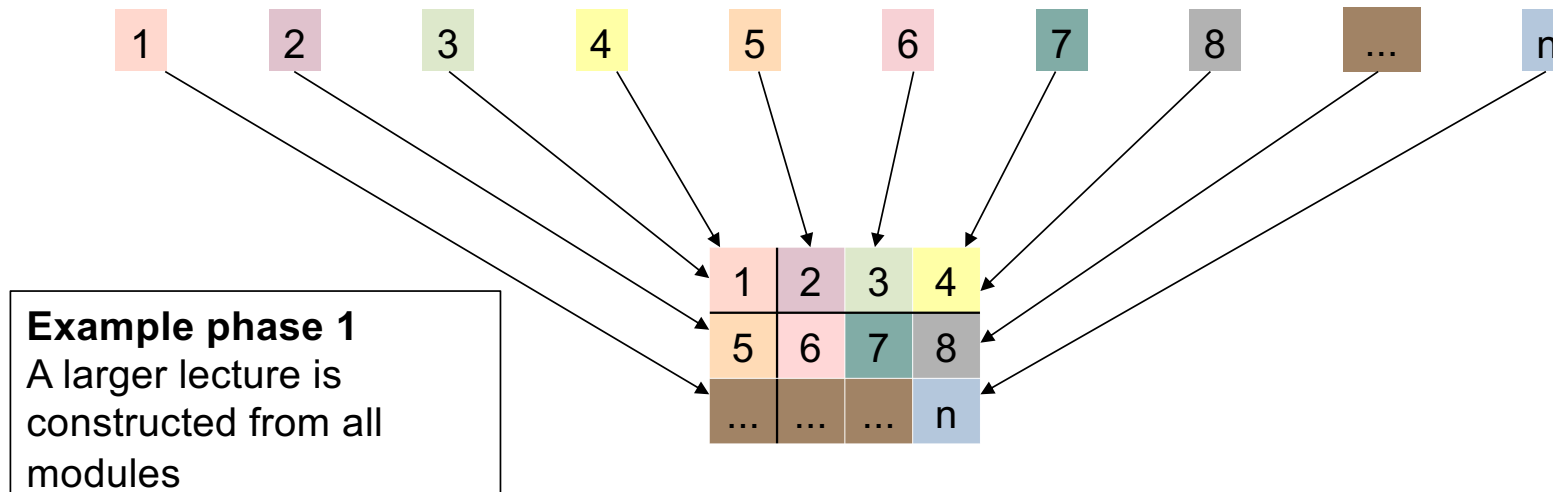and one module acts as
a gap filler

The CoP Approach – How to include Informatics education in general teacher education?

Creation of modular units, that are largely independent of each other and
can be used in all stages of teacher education

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | … | n |

4

Example phase 2 & 3
An in-service training is
constructed from a single
module

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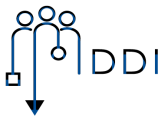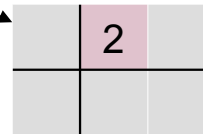torsten.brinda@uni-due.de
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The CoP Approach – How to include Informatics education in general teacher education?

Creation of modular units, that are largely independent of each other and can be used in all stages of teacher education
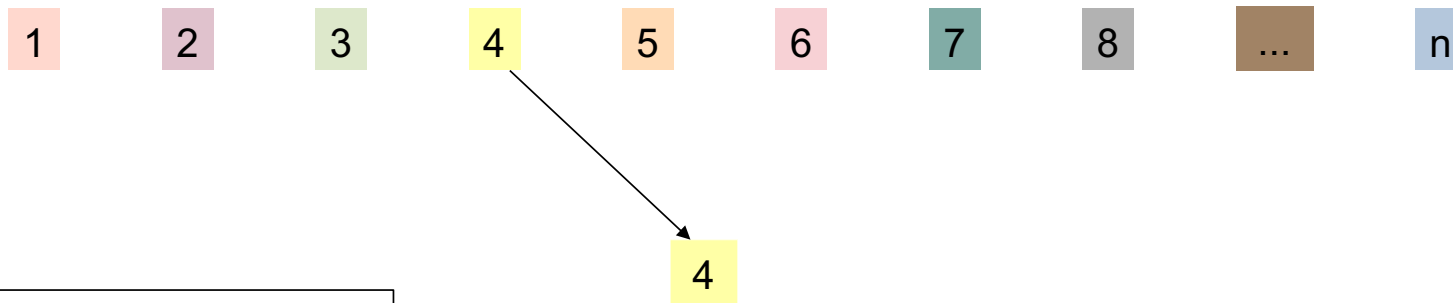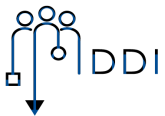

Example phase 2 & 3
An in-service training sequence is constructed from several modules
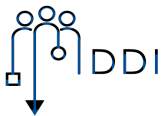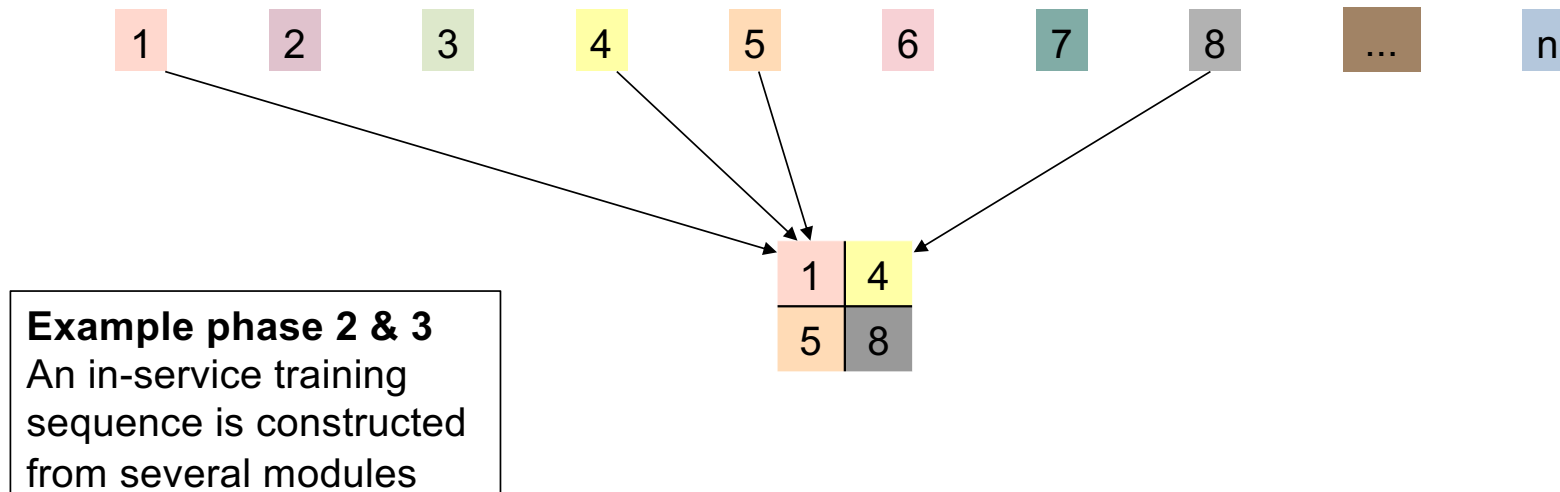
The CoP Approach – Which topics to include?

Conclusion: All participants from different stages were satisfied with the modular approach. But which topics should be covered?
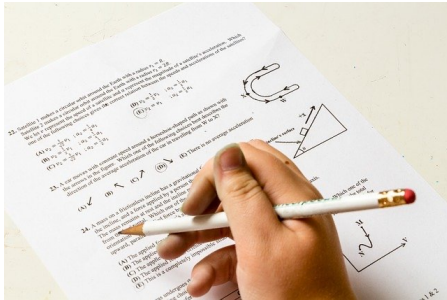
Which informatics competencies are necessary to fulfill these tasks in a competent manner?
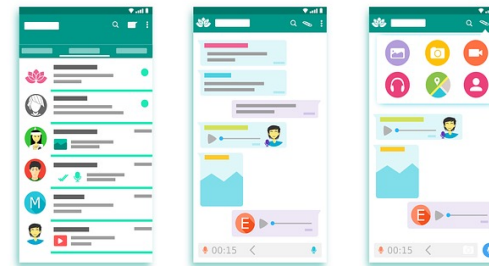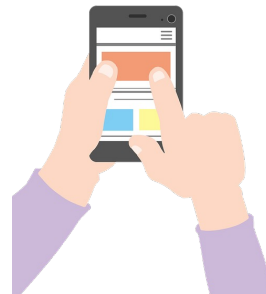
The CoP Approach – Which topics to include?
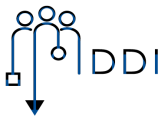
The "secure" chat with colleagues

- All teachers communicate with different persons, i. e. with other colleagues, their students, parents, school management etc

- Necessary that all teachers
  - can assess, which messenger to use for which scenario, based on different criteria
  - understand the models client-server vs. peer-to-peer
  - possess a scientifically correct conception of the structure of the internet as well as communication via internet, along with possible threat-scenarios

- In the interactive lecture, the students
  - learn about how communication in the internet works
  - describe their own experiences and requirements for a messenger they would use
  - establish, check and apply criteria for a secure messenger selection

Create, recall and protect data

- All teachers create digital data, e. g. as files, which they transfer to other devices and share with each other

- Files often contain private information about other persons (e. g. grades, addresses, telephone numbers etc.)

Name	Surname	Grade	Contact	Phone	Mail	Remark
Albright	Amalia	7	Anna (M)	0201/123	aa@gmail.com	
Baker	Bridget	7	Barack (F)	0201/456	bb@mail.com	
Clover	Charlie	8	Ben Miller (F)	0201/789	bm@aol.com	Diabetes
...	...	...	...	...	...	...

- What if such data gets lost?

Create, recall and protect data

- Necessary that all teachers
  - know how to protect their own data as well as data of other persons from unauthorized access, e. g. by using encryption
  - are able to back up their files and transfer files between devices without violating the protection of data privacy
  - can assess which apps and programs they can use in conformity with European GDPR

- In the interactive lecture, the students
  - reflect their own data handling
  - encrypt and decrypt files, directories or even whole devices
  - plan and implement backup strategies
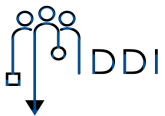
Further modules

- Informatics: from science to practice
  - What is Informatics?
  - Situations and problems

- Searching the Internet and text design
  - Client, server, protocol
  - Files
  - URLs, hypertext, cookies
  - Search engines (soekia.ch)
  - File formats
  - Document structures
  - LaTeX

- Artificial intelligence
  - Basic terms
  - Machine learning, neuronal networks
  - AI at school
    - Translation
    - Plagiat detection
    - Automatic assessment

- From paper to database
  - Absenteeism management
  - Spreadsheet vs. database
  - Basics of relational databases
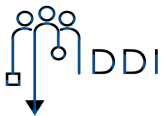
First experiences and next steps

- Pilot online lecture in summer term 2022 (as an extra-curricular activity)

- Students were interested, but some of them expressed difficulties in understanding basic Informatics terms (such as "source code").

- Most often, students had their cameras switched off and just interacted via chat.

- Students
  - considered the topics highly relevant for their later school life
  - wished for topics that are relevant for them NOW, i. e. things they could use during their study time at university

- Further experiments will be conducted in the 2nd and 3rd phase
  → teaching material needs to be transformed in a more activity-oriented style

Summary and conclusions

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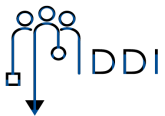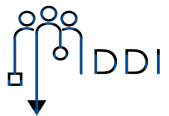
Summary and conclusions

- The digital transformation of the educational system is going forward with major steps.

- This is done by integrating computing systems in teachers' everyday lives.

- In order to develop *digital competences* it is absolutely necessary to develop Informatics competences.

  → Informatics must become a compulsory part of (all phases of) teacher education.

- Discussion needed with all stakeholders of teacher education:

  o WHY, HOW and WHERE to integrate informatics

  o Mandatory Informatics courses and/or integration in subject courses?

  o Transformation of curricula

o Similar questions and challenges as with bringing a mandatory school subject Informatics forward
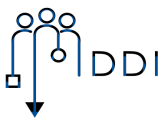
Your expertise and help are welcome

- We are looking for good practice examples

- GI working group has collected and published some examples (in German): https://ak-lk-bildung.gi.de/gute-beispiele

- If you can share further examples, please let the WG know: ak-lebi@gi.de

| Pflicht für alle: Medienbildung und Digitalisierung (UOL)	Wahlpflicht für alle: Informatik im Alltag - Durchblicken statt Rumklicken (BUW)	Informatische Bildung als Perspektive des Sachunterrichts im Praxissemester (BUW, DUE, WWUM)
Vorlesung und Seminar, 6 ECTS, (fast) alle Schulformen	Ringveranstaltung und Projektseminar, 3 + 2 ECTS, alle allgemeinbildenden Schulformen	Grundschule und Sonderpädagogik, 4 ECTS
Pflicht für alle Primarlehrkräfte in "Medien und Informatik" (PH Schwyz)	Obligatorische Weiterbildung aller PH Dozierenden aller Fächer (PH Schwyz)	Wahlpflicht für alle: IT4all (TUD)
mehrere Veranstaltungen, 7 ECTS, für alle Lehrpersonen für Kl. 1-6	Summerschool (1,5 Tage), Dozierende aller Fächer und Schulformen	Seminar, 2 ECTS, alle Schulformen
Online-Angebot: Digi4all (FUB, FAU, UBT)	Wahlpflicht für alle: Pixel, Byte & Co. (U Konstanz)	...
online-gestütztes Studienangebot zur Digitalen Bildung für Lehramtsstudierende aller Fächer und Schularten, 5 ECTS	Seminar, 3 ECTS, Gymnasien und berufliche Schulen	Hier könnte Ihr Beispiel stehen

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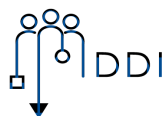
Many thanks for your attention! Questions?

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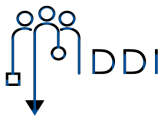torsten.brinda@uni-due.de
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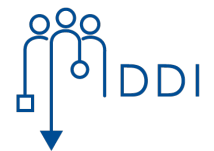
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