Pictures from IQB

Revised National Standards for Mathematics: The Story – New Challenges – Illustrative Examples

Bärbel Barzel, University of Duisburg-Essen

Onderwijs meets Onderzoek

IQB
Institut zur Qualitätsentwicklung im Bildungswesen

KMK
KULTUSMINISTER KONFERENZ

DZLM

IPN

UNIVERSITÄT DUISBURG ESSEN
Offen im Denken

The story

„We are diverse in Germany“

Each federal state is responsible for cultural and educational matters

BUT:
We have

KULTUSMINISTER KONFERENZ

(Standing Conference of the Ministers of Education & Cultural Affairs of the Länder)

1997„Konstanzer Resolution“
Germany participates in international comparisons studies (e.g. PISA, TIMSS)

Input-focused approach

↓

Output-focused approach

2003 National Standards

Mathematics, German, English

The story

2020 KMK decided revision of the National Standards
(Mathematics, German, English)
on the basis of a needs analysis,
(result: medium to high need for revision)

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im Bildungswesen

Ensure as much continuity as possible!

Goals resulting from needs analysis
(from research and administration)

- More **Coherence over the years**
- Integration of a **taxonomy of competencies for mathematical processes**
- **Concretisation** of all competencies
- Integrate a better concretization of **education in the digital era**

2016

2021

The story

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- Integrate a better concretization of **Education in the Digital World**

The story: Goals resulting from needs analysis

Coherence over the years – Core Ideas/ Content

Core Ideas from 2003 (Sec I):

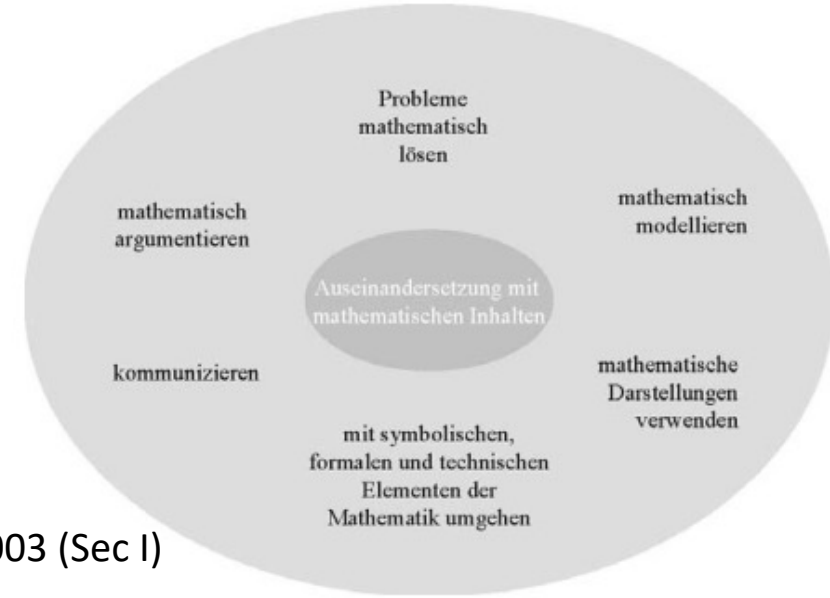
- Number
- Measuring
- Space and Shape
- Functional dependency
- Data and Chance

2022

Primary (1-4)	Secondary I (5 – 9/10)	Secondary II (10 - 12/13)
Number and Operation	Number and Operation	Algorithm and Number
Quantities and Measuring	Quantities and Measuring	Measuring
Patterns, Structures and Functional dependency	Structures and Functional dependency	Functional dependency
Space and Shape	Space and Shape	Space and Shape
Data and Chance	Data and Chance	Data and Chance

The story: Goals resulting from needs analysis

Coherence over the years – Mathematical Processes



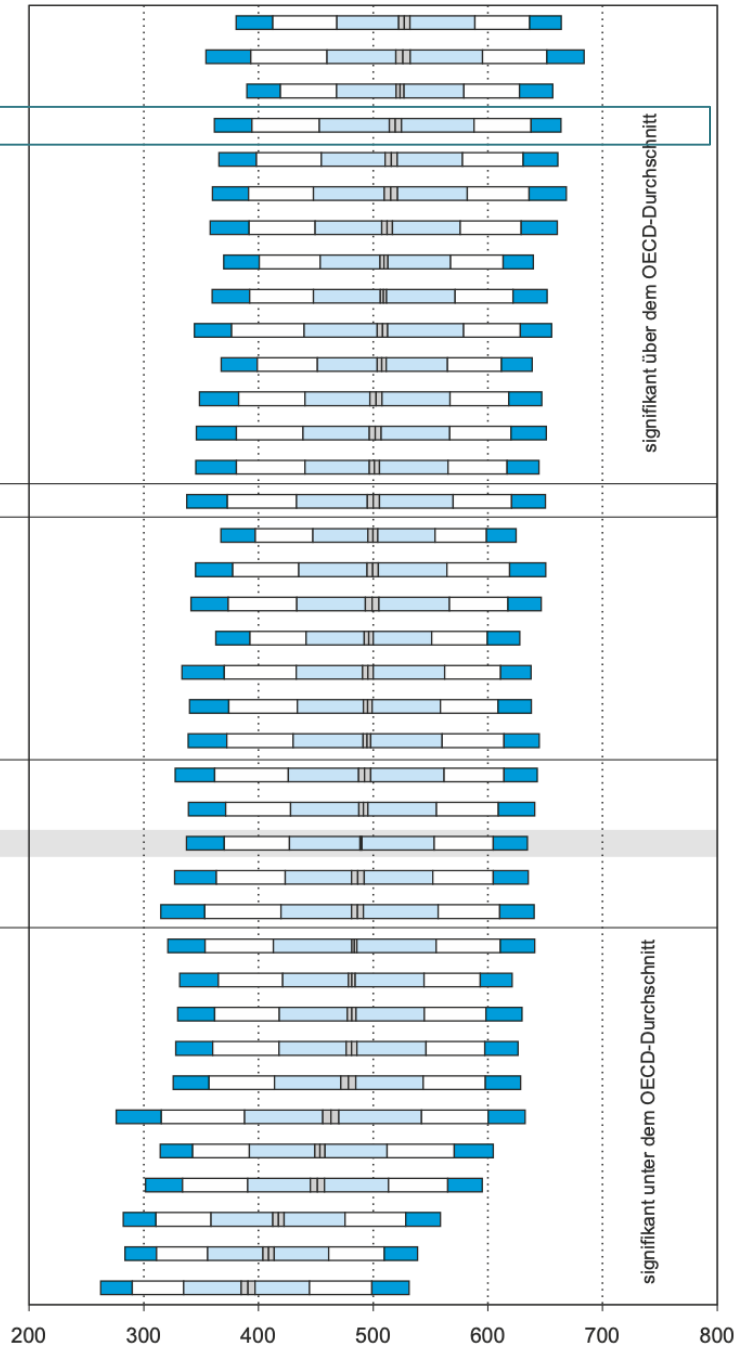
2003 (Sec I)

2022

Primary (1-4)	Secondary I (5 – 9/10)	Secondary II (10 - 12/13)
Mathematical arguing	Mathematical arguing	Mathematical arguing
Mathematical communicating	Mathematical communicating	Mathematical communicating
Solving problems mathematically	Solving problems mathematically	Solving problems mathematically
Mathematical modelling	Mathematisch modelling	Mathematical modelling
Mathematical representing	Mathematical representing	Using Mathematical representations
Working with mathematical objects and tools	Dealing with mathematical objects and tools	Dealing with symbolic, formal and technical elements of Mathematics
	Working with media mathematically	

NEW Challenge

OECD-Staaten	*M*	*SD*
Japan	527	86
Republik Korea	526	100
Estland	523	82
Niederlande	519	93
Polen	516	90
Schweiz	515	94
Kanada	512	92
Dänemark	509	82
Slowenien	509	89
Belgien	508	95
Finnland	507	82
Schweden	502	91
Vereinigtes Königreich	502	93
Norwegen	501	90
Deutschland	500	95
Irland	500	78
Tschechien	499	93
Österreich	499	93
Lettland	496	80
Frankreich	495	93
Island	495	90
Neuseeland	494	93
Portugal	492	96
Australien	491	92
OECD-Durchschnitt	489	91
Italien	487	94
Slowakei	486	100
Luxemburg	483	98
Spanien	481	88
Litauen	481	91
Ungarn	481	91
Vereinigte Staaten	478	92
Israel	463	108
Türkei	454	88
Griechenland	451	89
Chile	417	85
Mexiko	409	78
Kolumbien	391	81



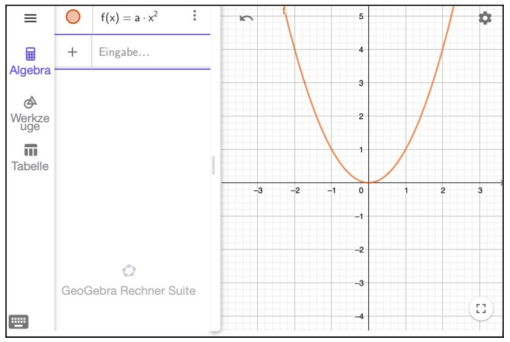
NEW Challenge: Education in the Digital World

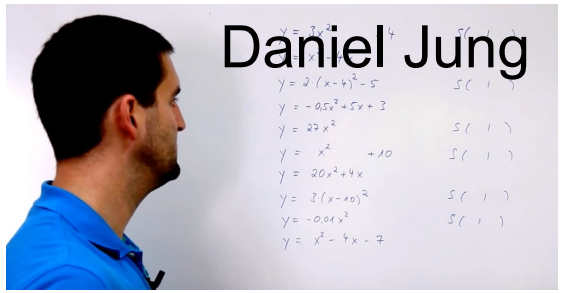
Use of digital media remains far behind expectations

(Lorenz et al. 2017; Kuntze & Dreher 2013; Weigand 2014; Heid et al. 2013)

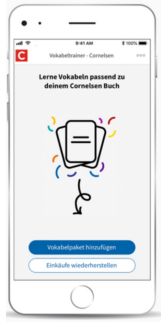
“quantitative and qualitative gap”

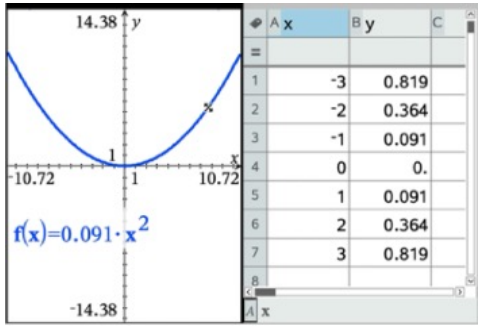
(Bretscher 2014, p. 43; Weigand, 2014; Heid, et al. 2013)

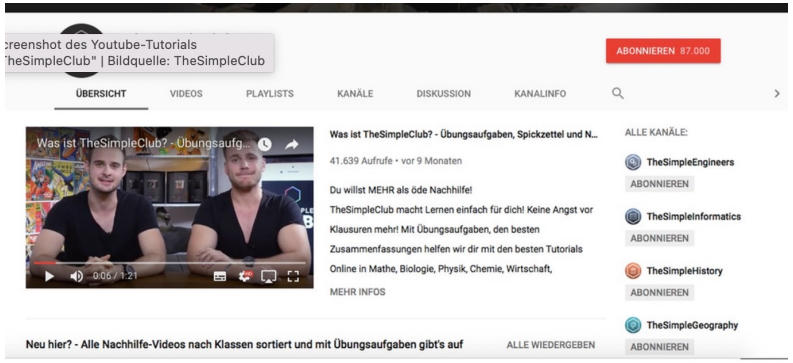




photomath





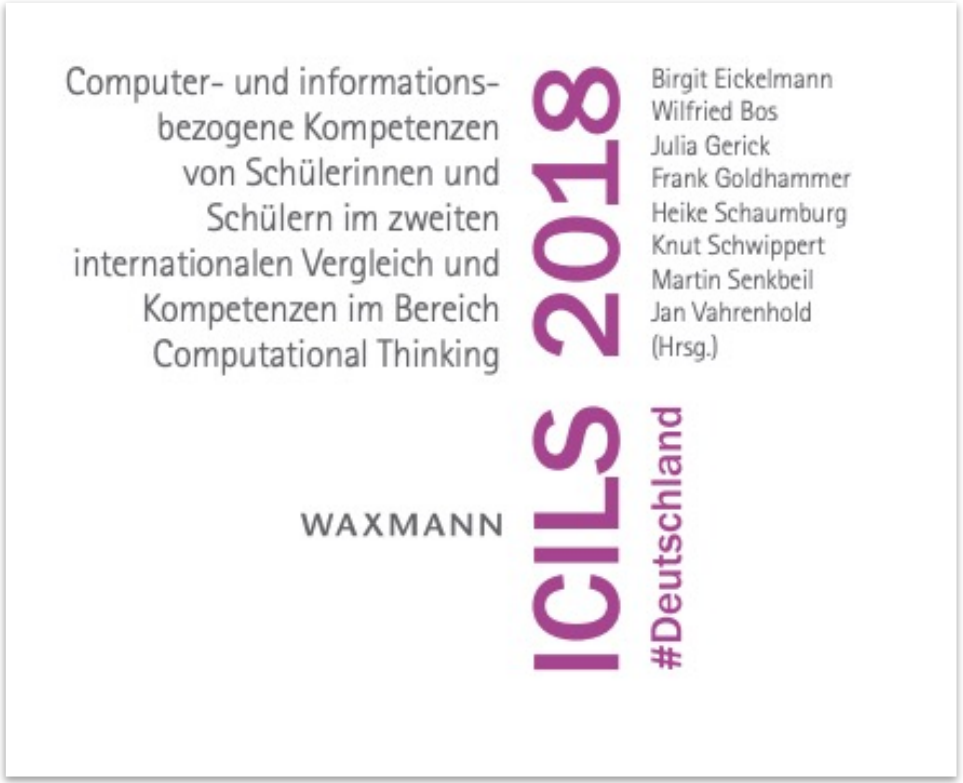


To integrate digital media in a meaningful way is a great challenge

NEW Challenge: Education in the Digital World

Use of digital media remains far behind expectations

(Lorenz et al. 2017; Kuntze & Dreher 2013; Weigand 2014; Heid et al. 2013)



Digital media are used with below-average frequency in the subjects in Germany in an international comparison.

The lowest percentage for Germany is found in mathematics (31.2%): Two thirds of 8th graders say they never work with media in Math. (Denmark: 96.9%)

Only 35% of teachers agree with the statement that the use of digital media can support pupils' learning processes.

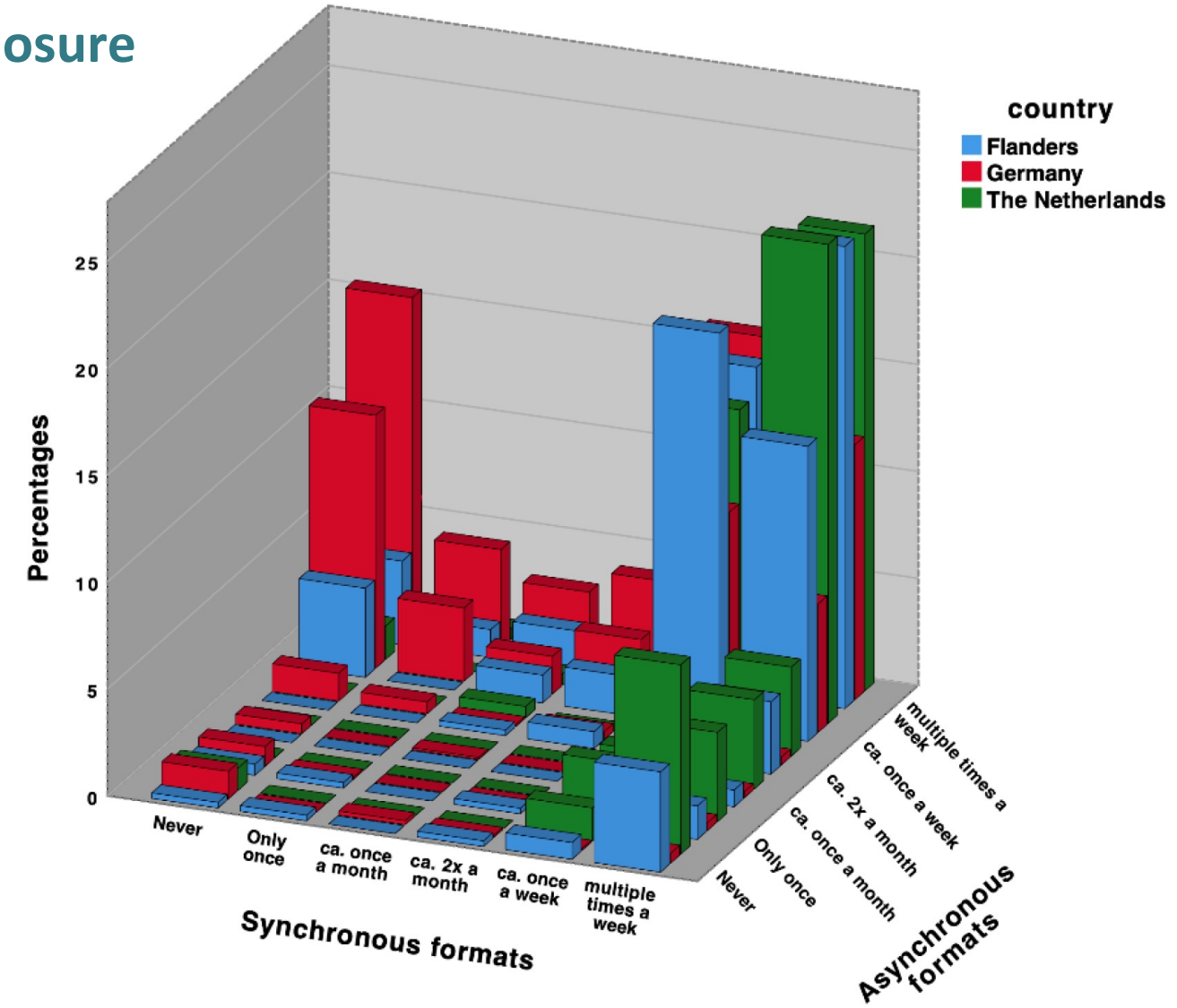
To integrate digital media in a meaningful way is a great challenge

New Challenge: Education in the Digital World

Learning mathematics in times of school closure

Math@distance

Study of the universities
Duisburg-Essen,
Utrecht &
Antwerpen with
1706 Math-Teachers



Drijvers et al. 2021, Thurm et al. 2023, Die Zeit, Nr. 32

New Challenge: Core Results of Math@Distance

April 2020		April 2021
↗	Significant development in the use of digital media (esp. For web conferencing) with increasing confidence in the use of digital media.	↗
↘	Maths-specific learning environments & diagnostic tools did not play an important role during the lockdown, although they were used before.	↔
↘	Decrease in classroom discussions as well as partner and group work phases.	↗
↘	Focus on practice and numeracy, less on conceptual understanding (especially in Germany)	↘
↔	Importance of infrastructure and support	↔

Drijvers et al. 2021, Thurm et al. 2022

New Challenge: Education in the Digital World

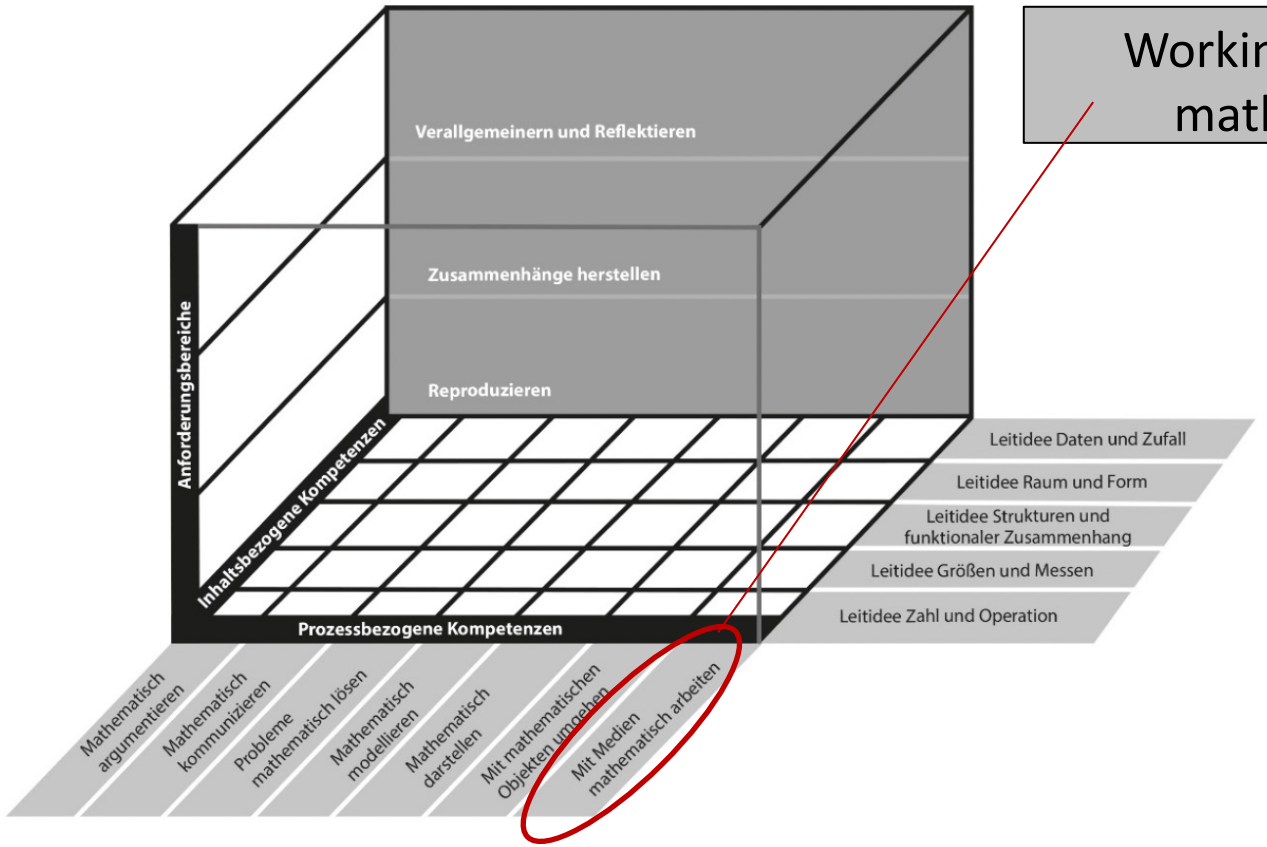


Abbildung 1: Kompetenzmodell der Bildungsstandards im Fach Mathematik für den Ersten Schulabschluss und den Mittleren Schulabschluss

Working with media mathematically

Supporting mathematical competencies digitally
(Learning WITH media)
&
Supporting digital competencies mathematically
(Learning ABOUT media)

Accompanying Pool of tasks on IQB-Webpage

IQB: Institut zur Qualitätsentwicklung im Bildungswesen

https://www.iqb.hu-berlin.de/bista/WeiterentwicklungBiSta/Lernaufgaben/MatheSekI

New Challenge: Education in the Digital World

Working with media mathematically

Supporting mathematical competencies digitally
(Learning WITH media)
&
Supporting digital competencies mathematically
(Learning ABOUT media)

The range of students‘ competences covers:

- the **use** of general media (analogue & digital)
- the **critical perception of information** from the digital world from a mathematical point of view,
- the **use of digital mathematics tools** and learning environments, and
- the **creation and design** of general media (e.g. videos presentations)
- the **development and reflection of algorithms** with the help of digital media.

New Challenge: Using the whole range of Digital Media

Learning WITH Media: Media are used in a reflective way to **support cognitive activities in learning or to support learning or enable new ones**

Learnin ABOUT Media: Pupils **get to know media, select them according to the goal, adapt them** if necessary and deal with them consciously and critically.

Digital Media

Digital Learning environments

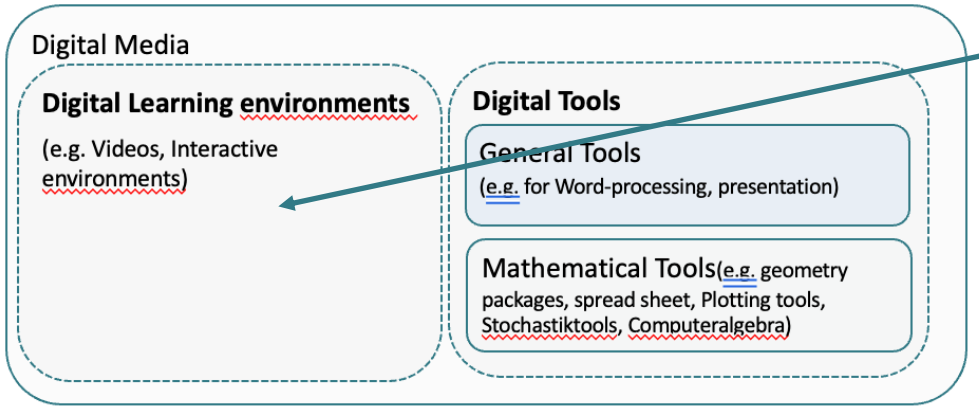
(e.g. Videos, Interactive environments)

Digital Tools

General Tools
(e.g. for Word-processing, presentation)

Mathematical Tools(e.g. geometry packages, spread sheet, Plotting tools, Stochastiktools, Computeralgebra)

Illustrative Examples



Digital Learning environments

(e.g. Videos, Interactive environments)

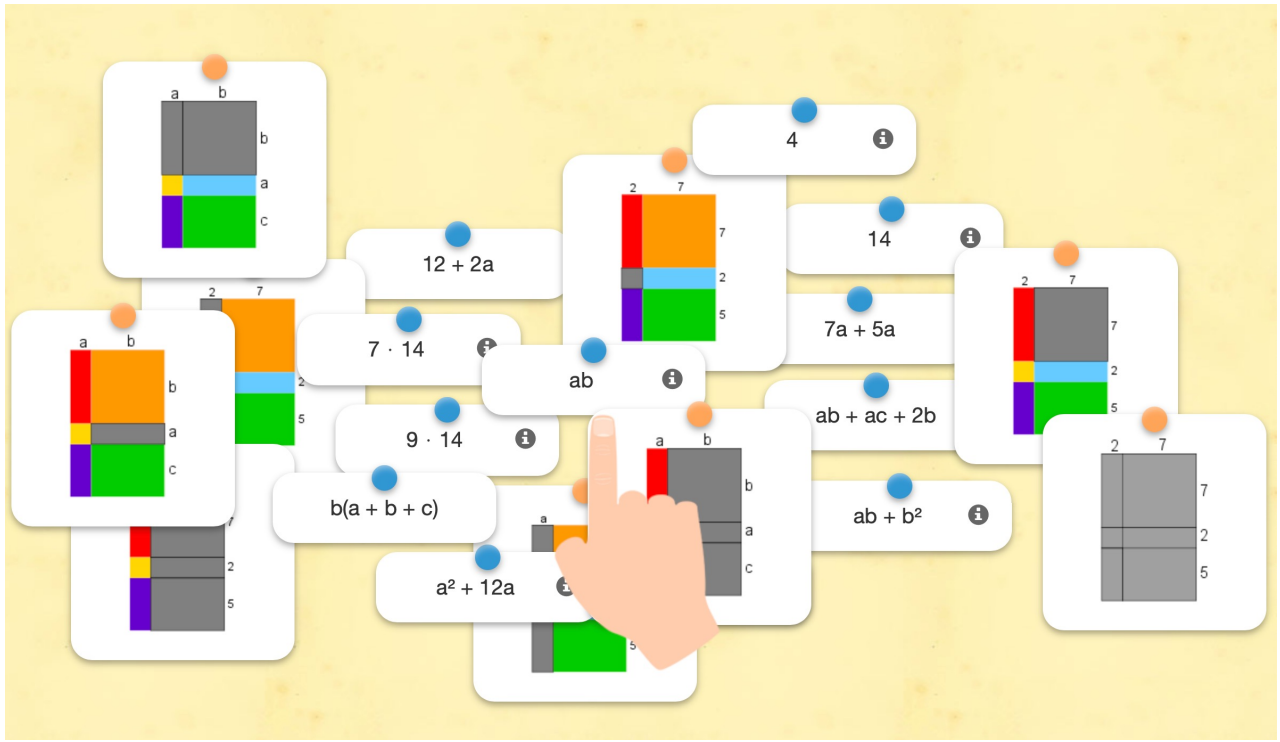
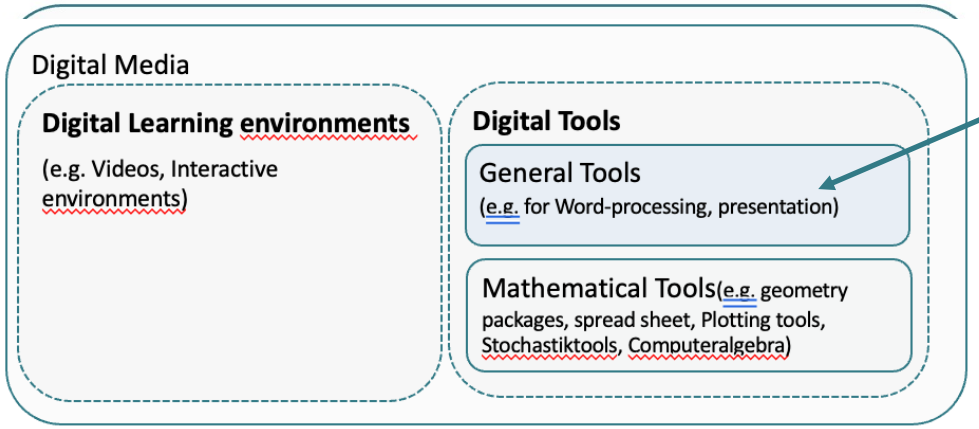


Abb. 6: (a) Idealisiertes Modell mit AR und (b) Abwicklung des Umwickelpapiers (erstellt mit GeoGebra 3D Rechner, Datei «Abrollen des Netzes eines Zylinders» von Birgit Lachner, https://www.geogebra.org/search/Zjr38uff).

https://www.iqb.hu-berlin.de/bista/WeiterentwicklungBiSta/Lernaufgaben/MatheSekI

Illustrative Examples



General Tools
(e.g. for Word-processing, presentation)

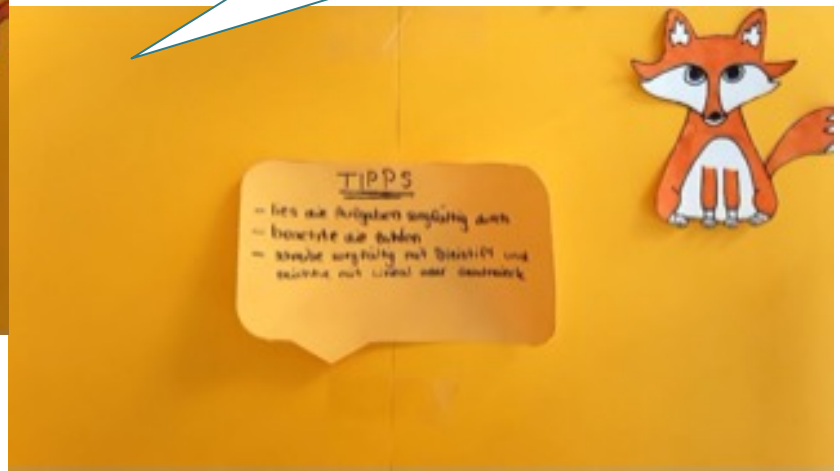
Students as recipient & producers of videos

MINT-Congress 2018 at Uni Duisburg-Essen:

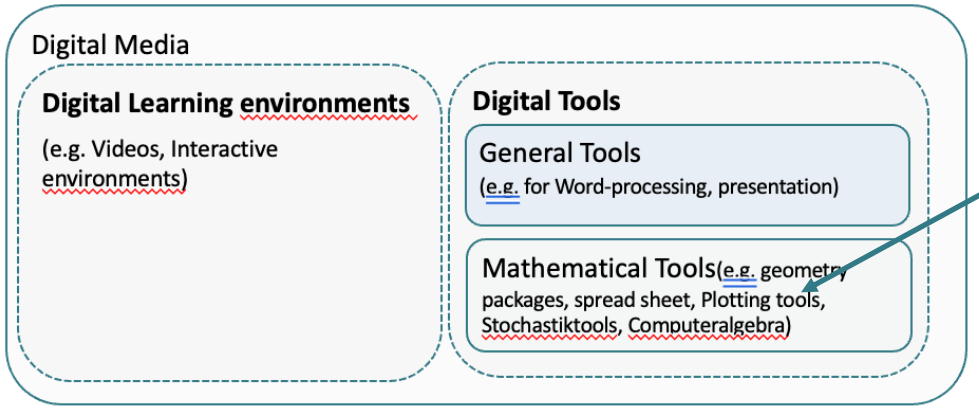
Bruchschule, Ruhr-Gymnasium, Vormholzer Grundschule - Witten

MIN(π)-ovate

„..they should have an idea in mind to understand it....



Illustrative Examples



Mathematical Tools(e.g. geometry packages, spread sheet, Plotting tools, Stochastiktools, Computeralgebra)

x km · 0,04 l/km · 1, 50€

Was kostet das Autofahren im Vergleich zum Bahnfahren?

a) Die Berechnung ist fast immer gleich. Meistens verändert sich nur die Kilometerzahl. Der Term dazu sieht so aus:
x·0,04+7,50 = y

Tabellenkalkulationsblatt zur Aufgabe Erkunden 4: Was kostet das Auto?

Wertverlust in 4 Jahren (in Euro)	Benzinpreis (in Euro pro Liter)	Kilometerzahl in 4 Jahren (im Kilometer)	Benzinkosten in 4 Jahren (in Euro)	Jährliche Reparatur / Steuer / Versicherung (in Euro)	Gesamtkosten in 4 Jahren (in Euro)
3000	2,05	40000	3280	900	9880

Story & Challenge: Program coherence to guide School Improvement

KULTUSMINISTER KONFERENZ

Often described challenge in TPD structures

Programs often fragmented, i.e.
- each TPD sends different messages
- connections hard to recognize
- teachers feel overload

Too much inert knowledge
- TPD course often do not prepare teaching practices
- Pedagogical content knowledge and teaching practices too unconnected

Facilitators miss coherent orientations
- missing coherent vision of quality math classrooms
- single TPD content not part of a larger whole
- missing connections

Educational Evaluation and Policy Analysis
Winter 2001, Vol. 23, No. 4, pp. 297–321

Instructional Program Coherence: What It Is and Why It Should Guide School Improvement Policy

Fred M. Newmann
University of Wisconsin, Madison

BetsAnn Smith
Michigan State University

Elaine Allensworth
Consortium on Chicago School Research

Anthony S. Bryk
University of Chicago

We present the concept of instructional program coherence and explain why school improvement frameworks that incorporate instructional program coherence are more likely to advance student achievement than multiple, unrelated efforts. We present evidence that Chicago elementary schools with stronger instructional program coherence make higher gains in student achievement. We also share observations on how, in specific schools, principals and external partners directed key school resources toward the development of instructional program coherence. In closing, we discuss factors within the educational system that discourage instructional program coherence and suggest ways that school leaders, school improvement partners, and policymakers can support greater instructional program coherence.

Story & Challenge: Program coherence to guide School Improvement

KULTUSMINISTER KONFERENZ

DZLM German Centre for Mathematics Teacher Education

IPN Leibniz-Institut für die Pädagogik der Naturwissenschaften und Mathematik

QuaMath

Unterrichts- und Fortbildungs-Qualität in Mathematik entwickeln

Coherent vision for high-quality mathematics teaching

QuaMath Unterrichts- und Fortbildungs-Qualität in Mathematik entwickeln

Cognitive demand:
Initiate active learning processes

Focus on understanding: of concepts, strategies and procedures

Longitudinal coherence:
Prepare for sustainable learning

Student focus & adaptivity:
Work with student perspectives

Enhanced communication:
Talk about mathematics

Prediger et al., 2022

Principles selected and articulated as coherent quality dimensions by

- intensive literature research
- tested in use (e.g. as coherent core for novice facilitators' practices)
- negotiated with the DZLM network and the state coordinators (teachers & stakeholders)

frontiers | Frontiers in Education

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Check for updates

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for specifying the content
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Five principles for high-quality mathematics teaching: Combining normative, epistemological, empirical, and pragmatic perspectives for specifying the content of professional development

Susanne Prediger[1,2,3]*, Daniela Götze[1,3], Lars Holzäpfel[1,4], Bettina Rösken-Winter[1,5] and Christoph Selter[1,3]

[1]German Center for Mathematics Teacher Education (DZLM Network), Network of 14 Universities, Berlin, Germany, [2]IPN–Leibniz Institute for Science and Mathematics Education, Berlin, Germany, [3]Mathematics Education, TU Dortmund University, Dortmund, Germany, [4]Mathematics Education, University of Education, Freiburg, Germany, [5]Primary Mathematics Education, Humboldt University of Berlin, Berlin, Germany

The academic search for principles of high-quality subject-matter teaching has been informed by different perspectives, in particular normative, epistemological, empirical, and pragmatic perspectives. While these perspectives have sometimes been treated as competing, we emphasize the need of their integration to identify sets of principles that can inform professional development programs for quality development. This paper

Coherent vision for high-quality mathematics teaching

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Cognitive demand:
Initiate active learning processes

Focus on understanding: of concepts, strategies and procedures

Longitudinal coherence:
Prepare for sustainable learning

Student focus & adaptivity:
Work with student perspectives

Enhanced communication:
Talk about mathematics

Digitalisation offers an opportunity for all principles!

(Prediger et al., 2022)

Illustrative Example: Space and Shape

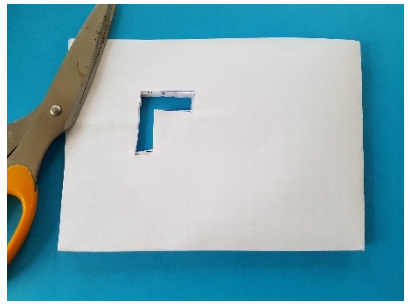
Cognitive demand:
Initiate active learning processes

Student focus & adaptivity:
Work with student perspectives

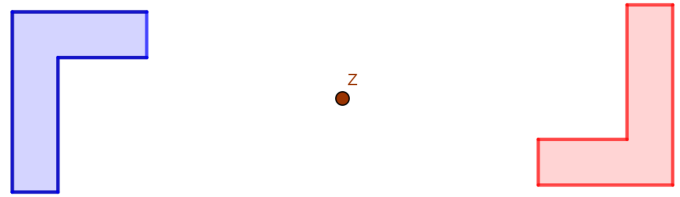
Focus on understanding: of concepts, strategies and procedures

Enhanced communication:
Talk about mathematics

Interplay of real & digital media



	Die Schülerinnen und Schüler…
inhaltsbezogene Kompetenz (Nicht angesprochene Bereiche der Teilkompetenz werden ausgegraut.)	**Raum und Form:** • entwickeln Vorstellungen im zwei- und dreidimensionalen Raum und operieren (insbesondere verschieben, drehen, spiegeln) gedanklich mit den darin enthaltenen Objekten (Punkten, Strecken, Flächen und Körpern).
prozessbezogene Kompetenzen (AFB)	**mathematisch darstellen:** • nutzen und erzeugen vertraute und geübte Darstellungen von mathematischen Objekten und Situationen (AFB I) **mit Medien mathematisch arbeiten:** • nutzen analoge und digitale Mathematikwerkzeuge (z. B. Geometriesoftware, Tabellenkalkulation, Computeralgebrasystem, Stochastiktool1) zum Problemlösen, Entdecken, Modellieren, Daten verarbeiten, Kontrollieren und Darstellungswechseln etc., (AFB II)



Investigate whether a single axis mirroring can be performed instead of the point mirroring with the same result.

Illustrative Example: Structures and Functional dependency

Cognitive demand:
Initiate active learning processes

Student focus & adaptivity:
Work with student perspectives

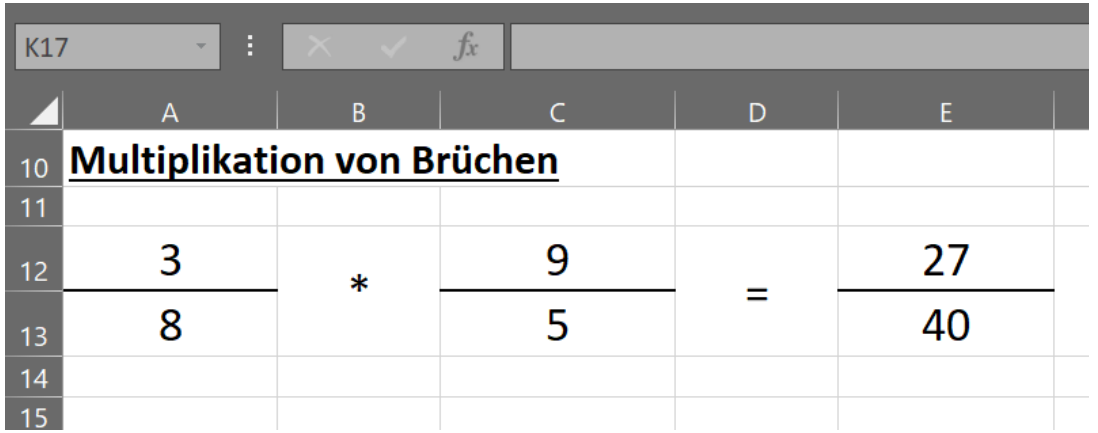
Focus on understanding: of concepts, strategies and procedures

Enhanced communication:
Talk about mathematics

„....implement known mathematical procedures as algorithms using digital tools (e.g. spreadsheets)“

Any two fractions are to be multiplied together.
Each fraction is to be displayed as a fraction

(i) Create the machine.....
(ii) Check that it works correctly. ...
(iii) Save your file.....

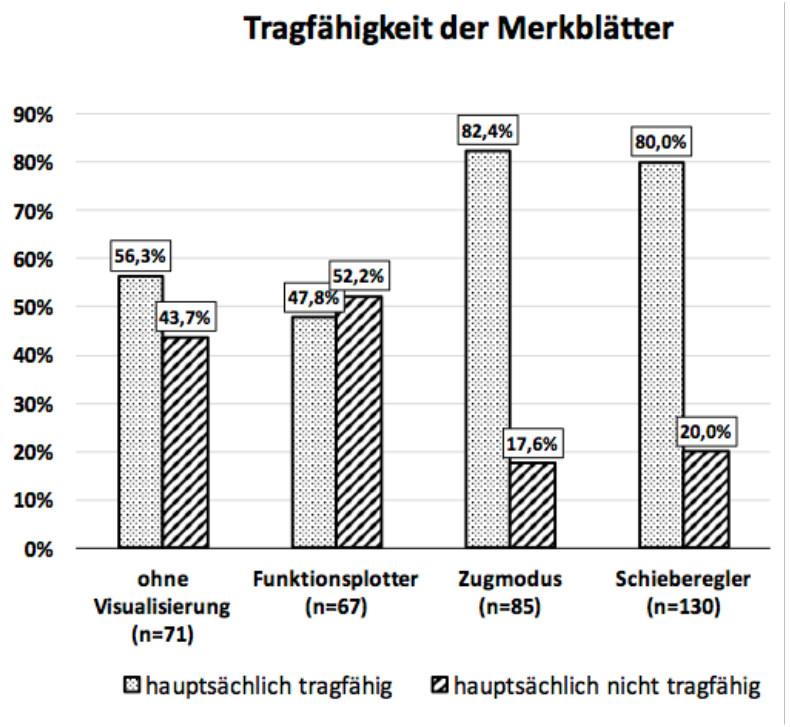


„Fraction-Calculating-Machine“

Illustrative Example: Structures and Functional dependency

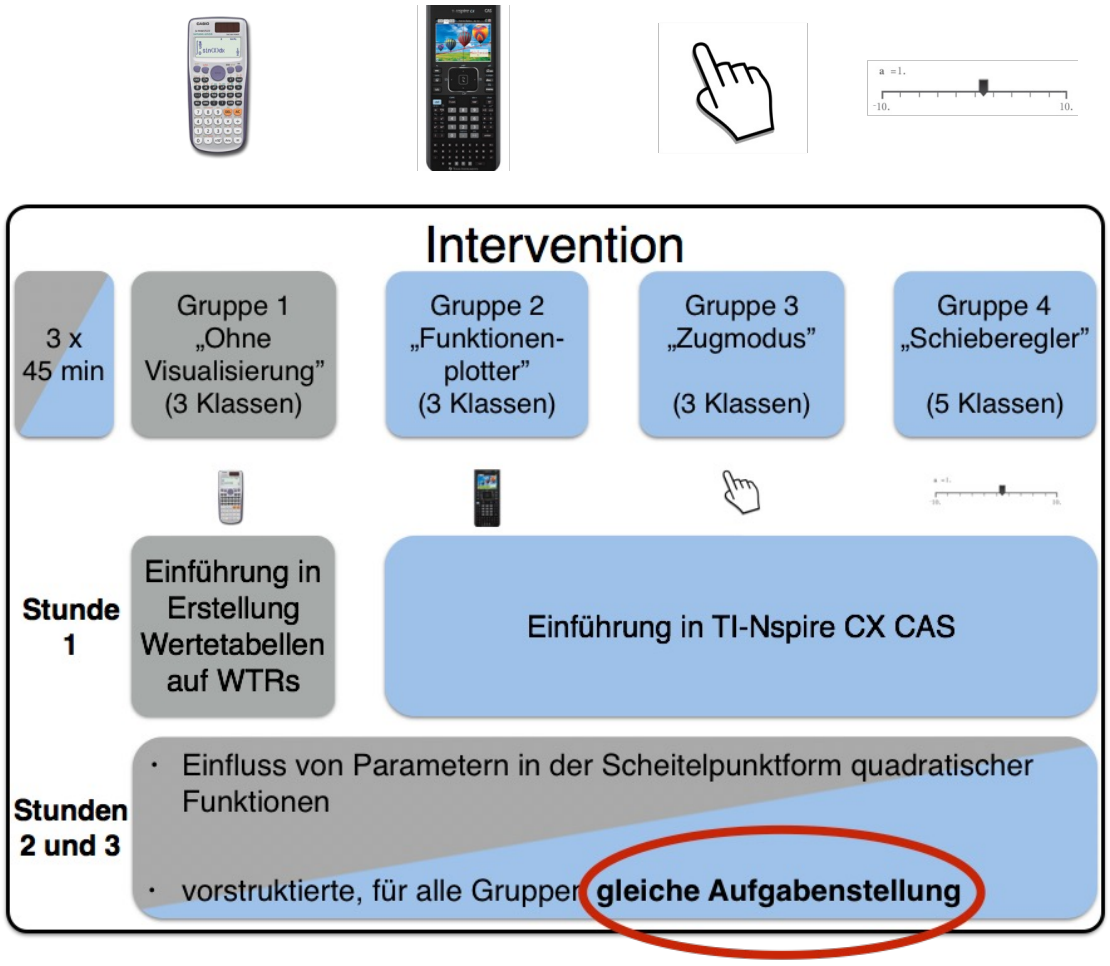
Cognitive demand:
Initiate active learning processes

Focus on understanding: of concepts, strategies and procedures



The groups with dragmode and sliders note much more meaningful answers on their summary sheets

Investigating the meaning of the parameters a,b and c in $f(x) = a\,(x - b)^2 + c$



Göbel 2021

Illustrative Example: Structures and Functional dependency

Cognitive demand:
Initiate active learning processes

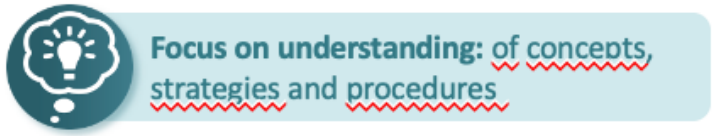
Focus on understanding: of concepts, strategies and procedures

Investigating the meaning of the parameters a,b and c in $f(x) = a\,(x - b)^2 + c$

Parameter	Category	*Without visualization*	*Function Plotter*	*Drag mode*	*Sliders*
a	Vertical Shrink				
	Vertical Stretch				
	Reflection				
	Case $a = 0$				
b	Right				
	Left				
	Horizontal				
c	Upwards				
	Downwards				
	Vertical				

The potentials and burdens are much more manifold than expected
Sliders play the role of an „external“ variable

Illustrative Example: Structures and Functional dependency



... know about basic ideas (Grundvorstellungen) and link relevant representations

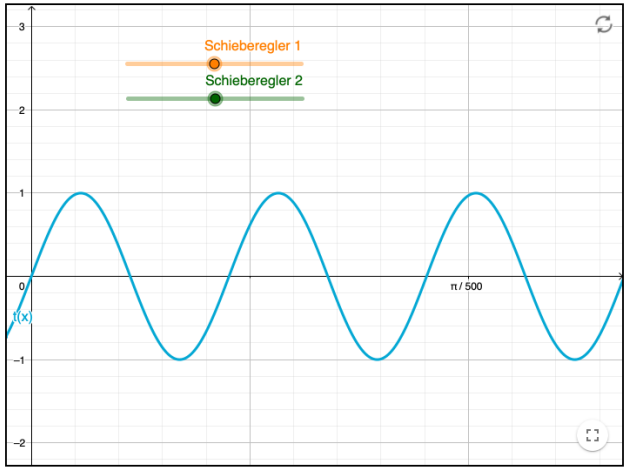
...knowing about the meaning and sense

Aufgabentitel	**Töne mit Sinusfunktionen modellieren und untersuchen**		
Ziele der Aufgabe	Die Schülerinnen und Schüler entdecken die Bedeutung der Parameter der Sinusfunktion im musikalischen Kontext von Tönen, anhand der App Mathe-Synthesizer.		
Bildungsstufe Klassenstufe	☐ ESA ☒ MSA ☐ Beide 10	Bearbeitungszeit gesamt in Minuten	45-60 Minuten
Leitidee 1	Strukturen und funktionaler Zusammenhang	Leitidee 2	Bitte wählen
Einsatz von (digitalen) Medien	App: „Mathe-Synthesizer“	Unterrichtsphase	1,2: Entdecken/Einstieg 2: Systematisieren

Students discover the meaning of parameters at sine function in the context of sound & music

Illustrative Example: Structures and Functional dependency

Focus on understanding: of concepts, strategies and procedures



Einfluss der Schieberegler | Beschreibung

Aa π Gib hier deine Antwort ein...

Beschriftung: Schieberegler 1

Aa π Gib hier deine Antwort ein...

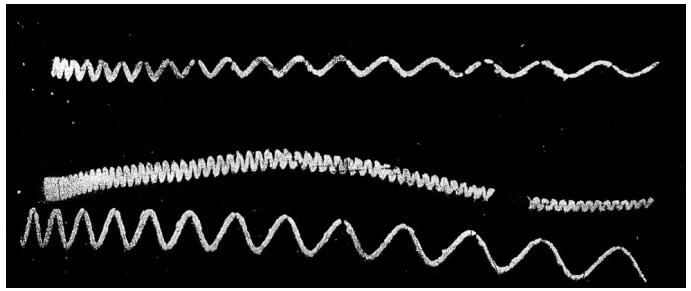
Beschriftung: Schieberegler 2

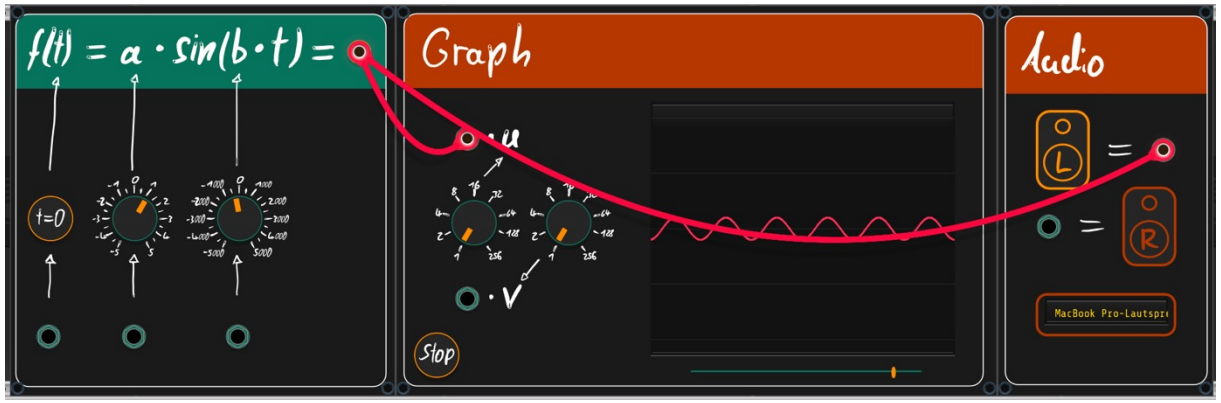
Aa π Gib hier deine Antwort ein...

← Vorherig
Den Sinus hören? - Transformationen der Sinus-Funkt...

Weiter
Ein kleines Tonlabor →

Max Hoffmann, Uni Paderborn





Nicolas Regel, TU Dresden

https://www.iqb.hu-berlin.de/bista/WeiterentwicklungBiSta/Lernaufgaben/MatheSekI

Illustrative Example: Data and Chance

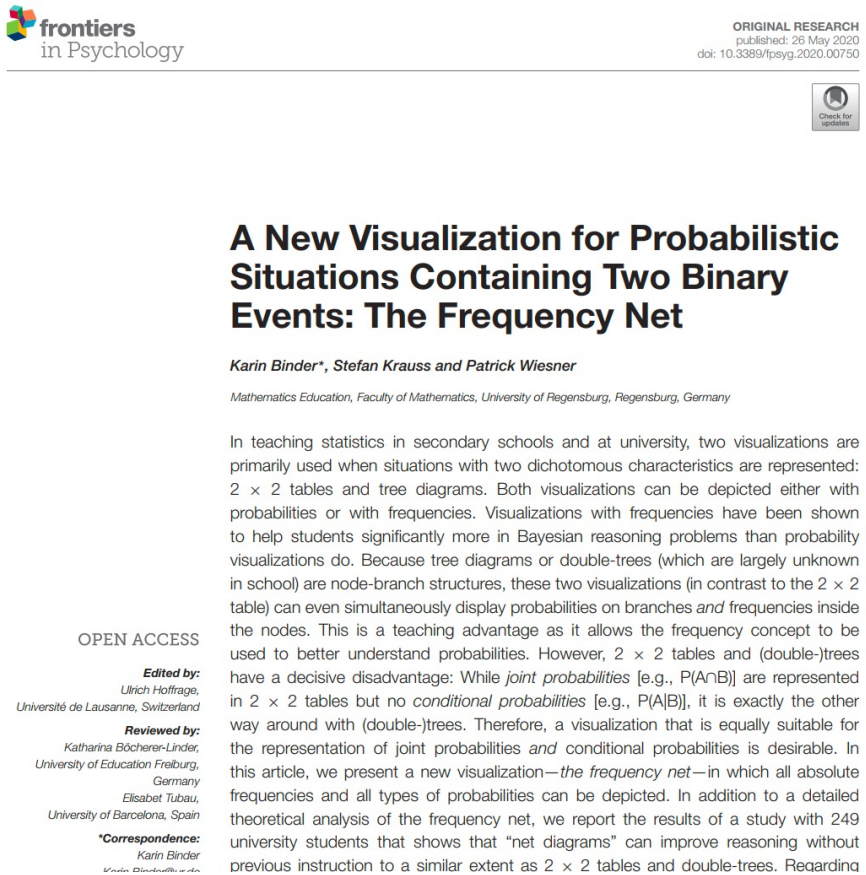
Conditional probability as new topic in Secondary I

	Die Schülerinnen und Schüler...
inhaltsbezogene Kompetenz (Nicht angesprochene Bereiche der Teilkompetenz werden ausgegraut.)	**Daten und Zufall:** Werten grafische Darstellungen und Tabellen von statistischen Erhebungen aus, auch mit Hilfe von Tabellenkalkulation oder Stochastiktools **Nutzen Visualisierungen, um bei einfachen alltagsnahen Modellierungen bedingte Wahrscheinlichkeiten zu erkennen, ohne und mit Hilfe digitaler Medien (MSA)** ODER: **Zahl und Operation:** nutzen sinntragende Vorstellungen von rationalen Zahlen, insbesondere von natürlichen, ganzen und gebrochenen Zahlen entsprechend der Verwendungsnotwendigkeit, erläutern an Beispielen die verschiedenen Vorstellungen zum Bruchbegriff (insbesondere Teile eines oder mehrerer Ganzer, relative Anteile),
prozessbezogene Kompetenzen	**Mathematisch kommunizieren:** gehen fachbezogen auf Äußerungen von anderen zu mathematischen Inhalten ein (z. B. konstruktiver Umgang mit Fehlern, Weiterführen mathematischer Ideen) **Mathematisch argumentieren:** bewerten Ergebnisse und Aussagen auch bzgl. ihres Anwendungskontextes **Mathematisch darstellen:** wechseln sachgerecht zwischen mathematischen Darstellungen und erklären, wie sie vernetzt sind

Students use visualisations to identify conditional probabilities in simple everyday modelling....

Illustrative Example: Data and Chance

Conditional probability as new topic in Secondary I



frontiers in Psychology

ORIGINAL RESEARCH
published: 26 May 2020
doi: 10.3389/fpsyg.2020.00750

A New Visualization for Probabilistic Situations Containing Two Binary Events: The Frequency Net

Karin Binder, Stefan Krauss and Patrick Wiesner*

Mathematics Education, Faculty of Mathematics, University of Regensburg, Regensburg, Germany

In teaching statistics in secondary schools and at university, two visualizations are primarily used when situations with two dichotomous characteristics are represented: 2 × 2 tables and tree diagrams. Both visualizations can be depicted either with probabilities or with frequencies. Visualizations with frequencies have been shown to help students significantly more in Bayesian reasoning problems than probability visualizations do. Because tree diagrams or double-trees (which are largely unknown in school) are node-branch structures, these two visualizations (in contrast to the 2 × 2 table) can even simultaneously display probabilities on branches *and* frequencies inside the nodes. This is a teaching advantage as it allows the frequency concept to be used to better understand probabilities. However, 2 × 2 tables and (double-)trees have a decisive disadvantage: While *joint probabilities* [e.g., P(A∩B)] are represented in 2 × 2 tables but no *conditional probabilities* [e.g., P(A|B)], it is exactly the other way around with (double-)trees. Therefore, a visualization that is equally suitable for the representation of joint probabilities *and* conditional probabilities is desirable. In this article, we present a new visualization—*the frequency net*—in which all absolute frequencies and all types of probabilities can be depicted. In addition to a detailed theoretical analysis of the frequency net, we report the results of a study with 249 university students that shows that "net diagrams" can improve reasoning without previous instruction to a similar extent as 2 × 2 tables and double-trees. Regarding

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Students use visualisations to identify conditional probabilities in simple everyday modelling....

Binder, Krauss & Wiesner 2020

Illustrative Example: Data and Chance

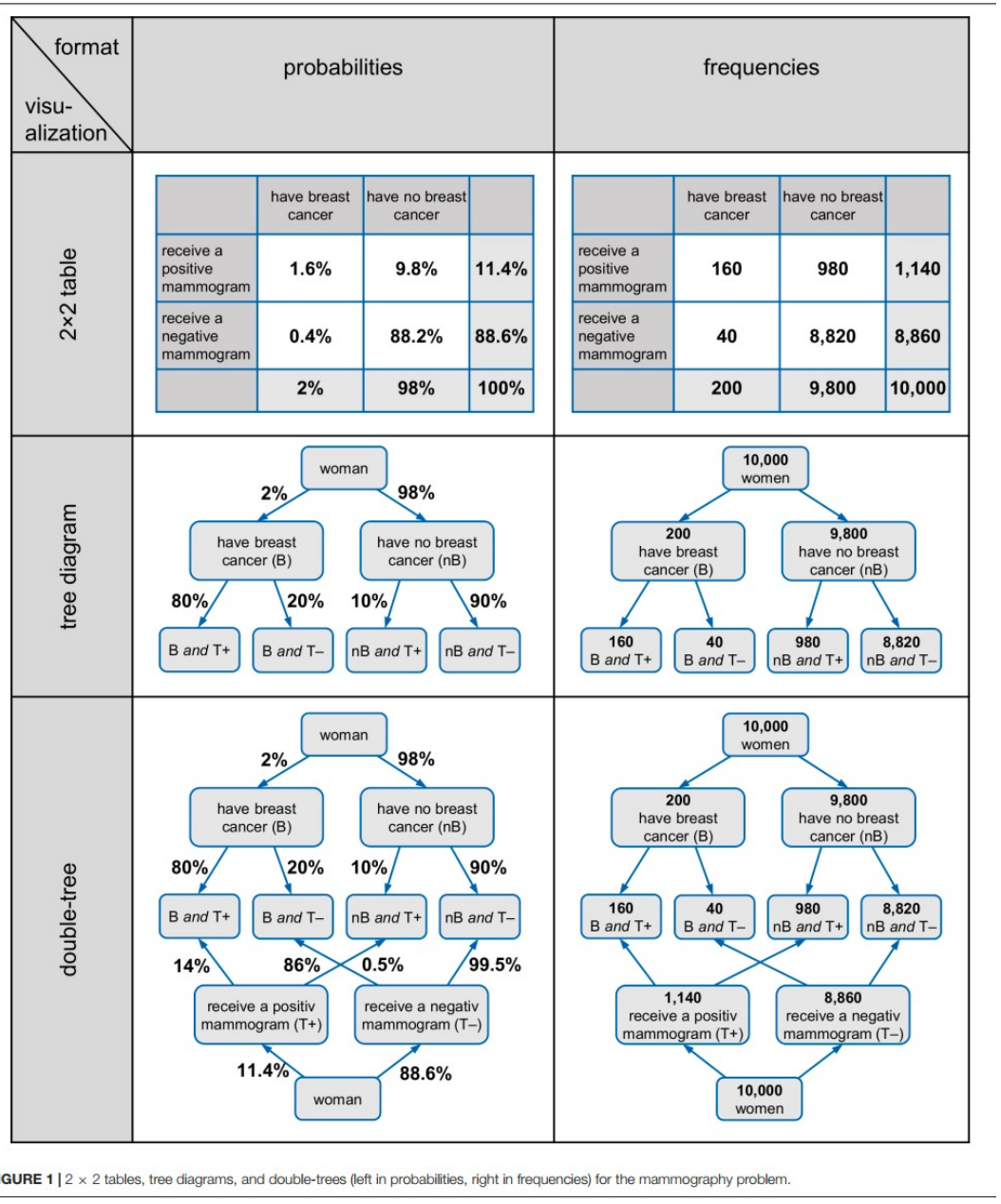
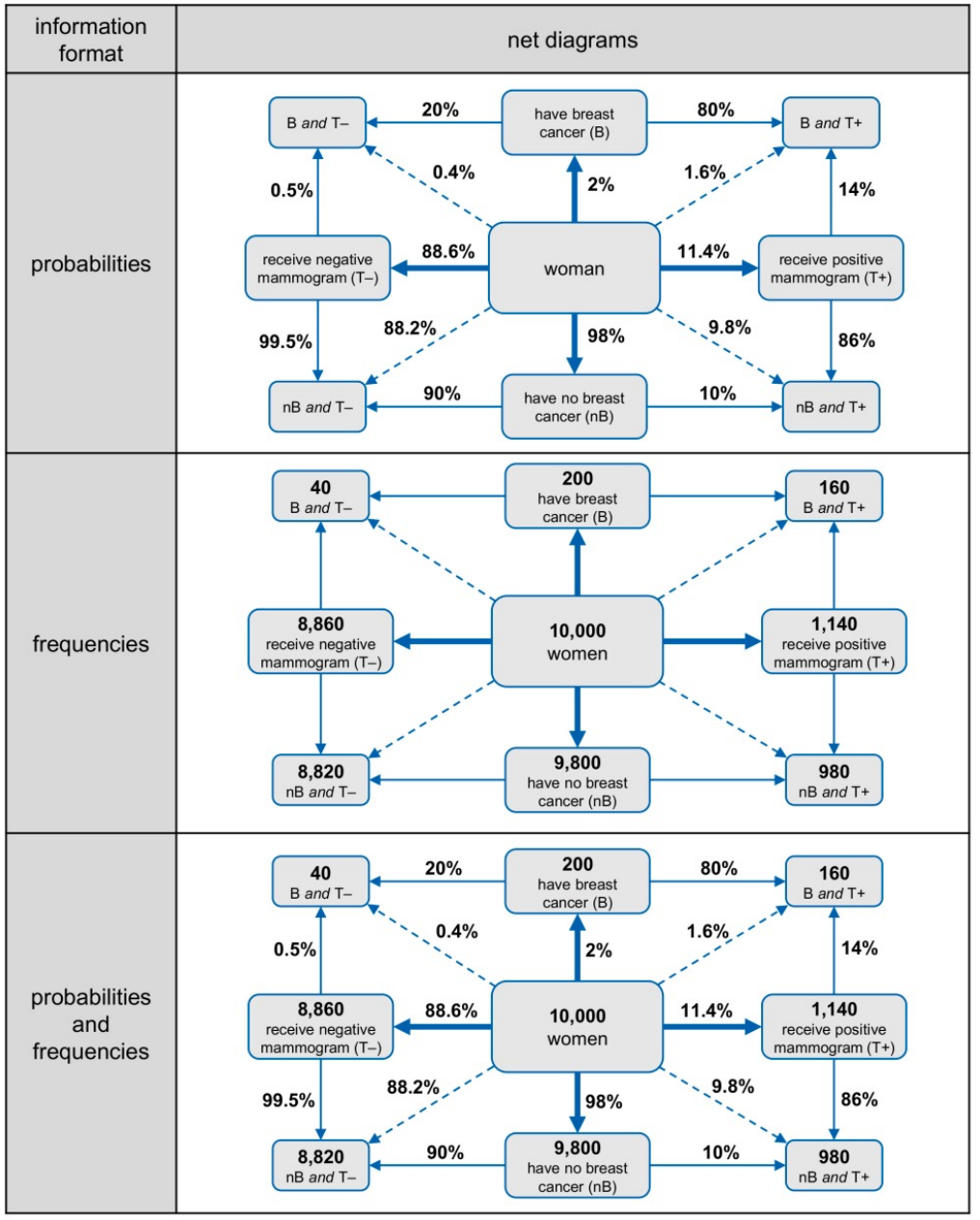


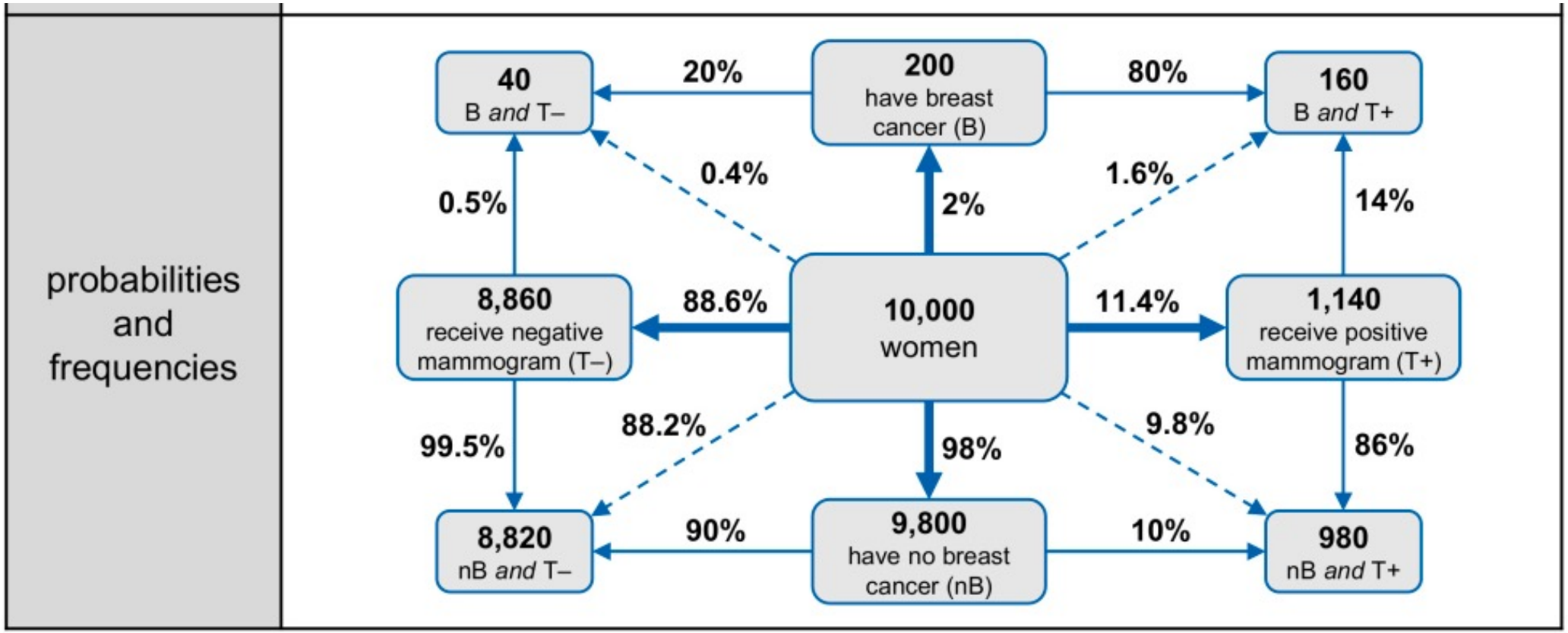
FIGURE 1 | 2 × 2 tables, tree diagrams, and double-trees (left in probabilities, right in frequencies) for the mammography problem.



Binder, Krauss & Wiesner 2020

Illustrative Example: Data and Chance

Frequency net



Binder, Krauss & Wiesner 2020

Illustrative Example: Data and Chance

Cognitive demand: Initiate active learning processes

Student focus & adaptivity: Work with student perspectives

Focus on understanding: of concepts, strategies and procedures

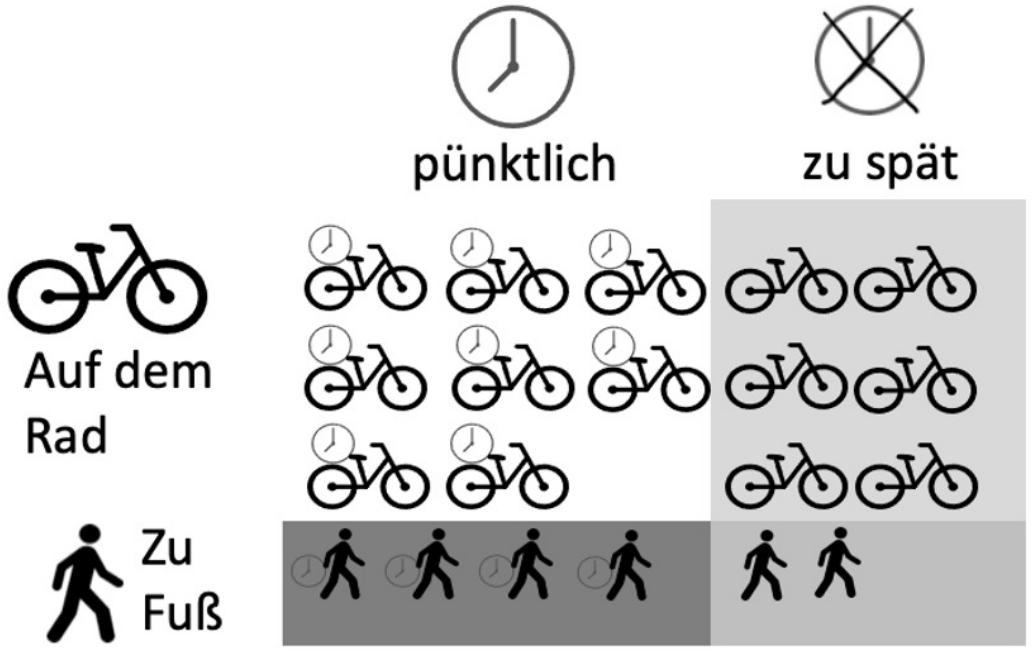
Enhanced communication: Talk about mathematics

Conditional probability as new topic in Secondary I

In Cem and Anna's class, pupils are often late. There is a heated discussion about who is actually late. The class has conducted a survey on this. There are 20 children in the class.

Anna

The most of those being late come by bike

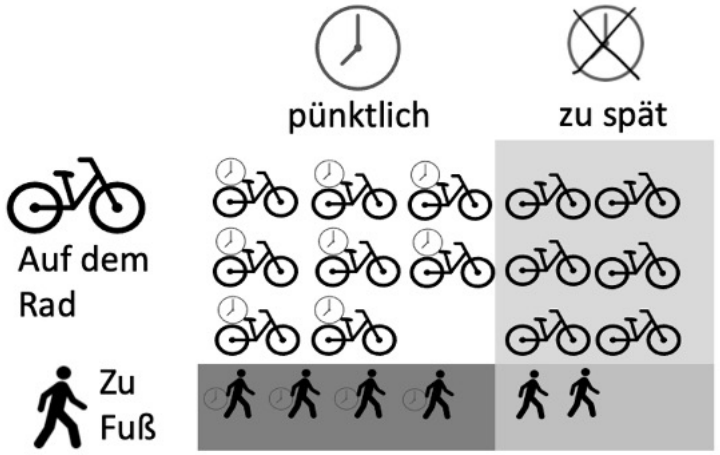


Cem

Funny, I thought most of those who come by bike are on time.

Binder, Steib & Krauss 2022, Binder et al. 2021, Binder, Krauss & Wiesner 2020

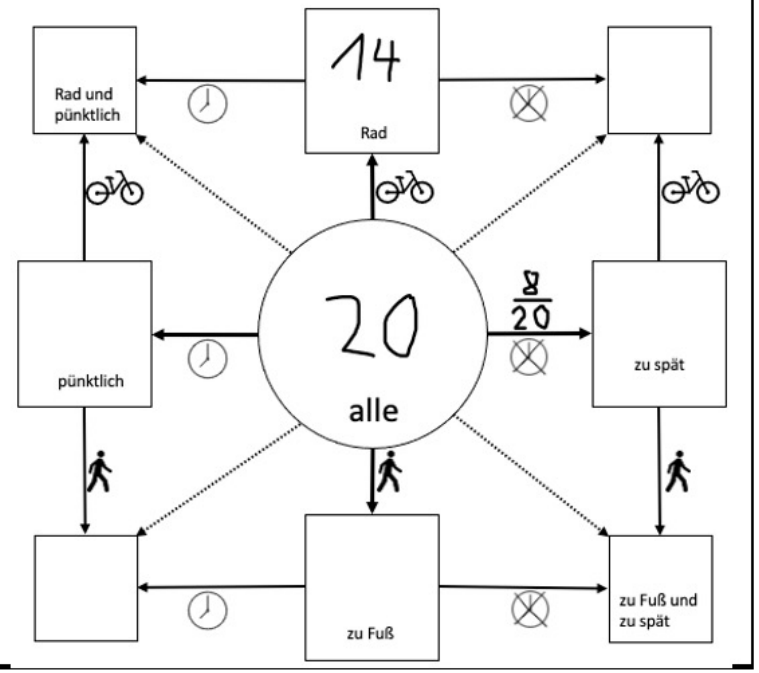
Illustrative Example: Data and Chance



Absolute Häufigkeiten in der Vierfeldertafel

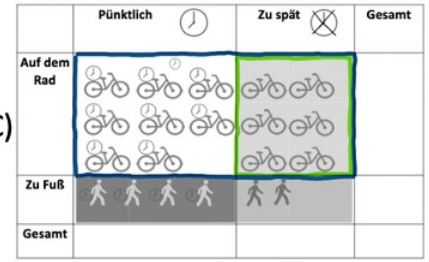
	Pünktlich	Zu spät	Ge-samt
Auf dem Rad			
Zu Fuß			
Gesamt			20

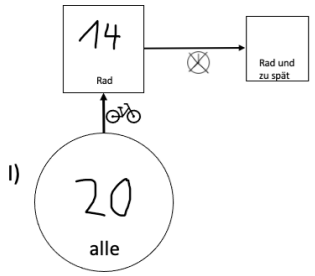
Absolute Häufigkeiten im Häufigkeitsnetz



$\frac{6}{14}$

The part of cyclists who arrive late



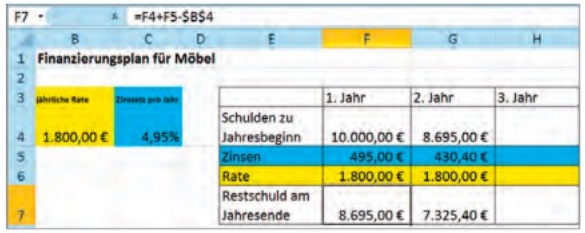


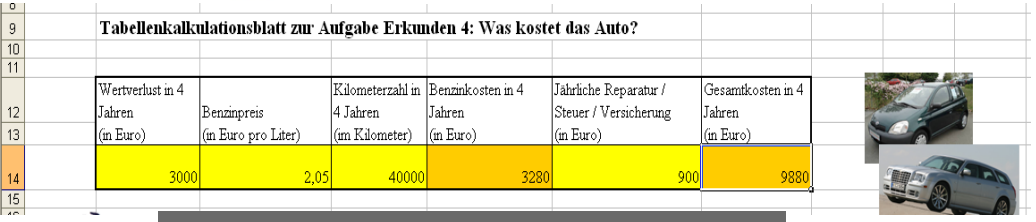
Binder, Steib & Krauss 2022, Binder et al. 2021, Binder, Krauss & Wiesner 2020

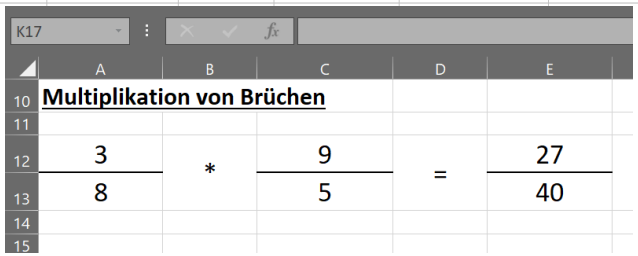
Coherence over the years

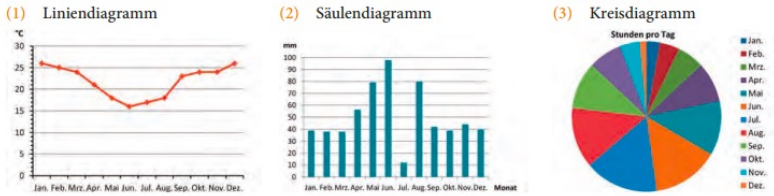
Longitudinal coherence:
Prepare for sustainable learning

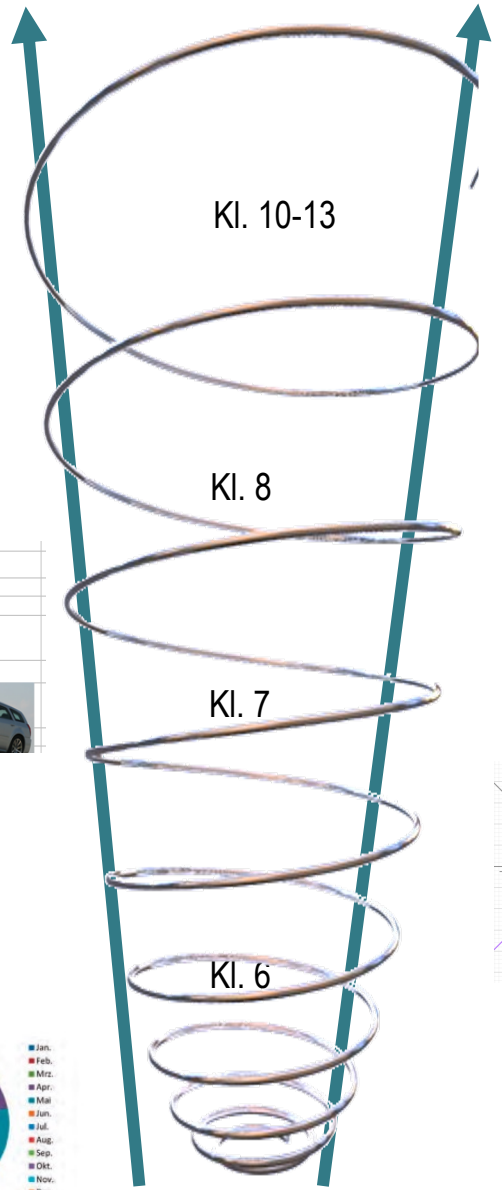
Mathematical Tools (e.g. geometry packages, spread sheet, Plotting tools, Stochastiktools, Computeralgebra)

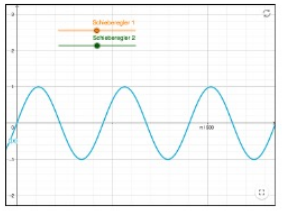


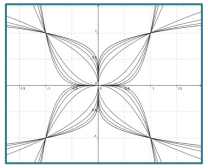


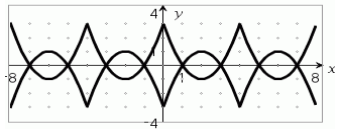


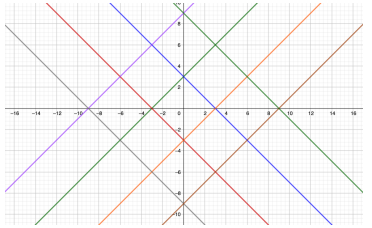










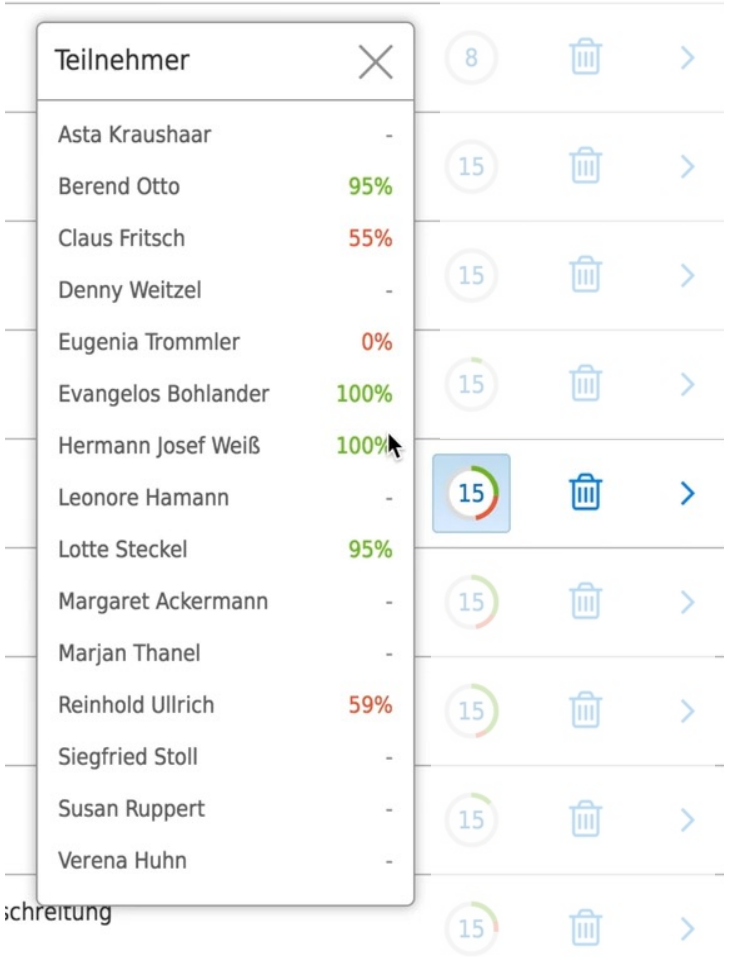


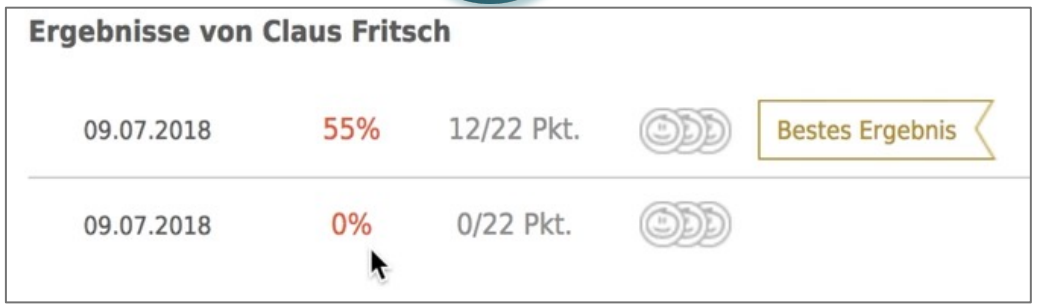
As well for
- Geometry/ DGS
- Stochastics/ ST

Digital diagnostics in Germany

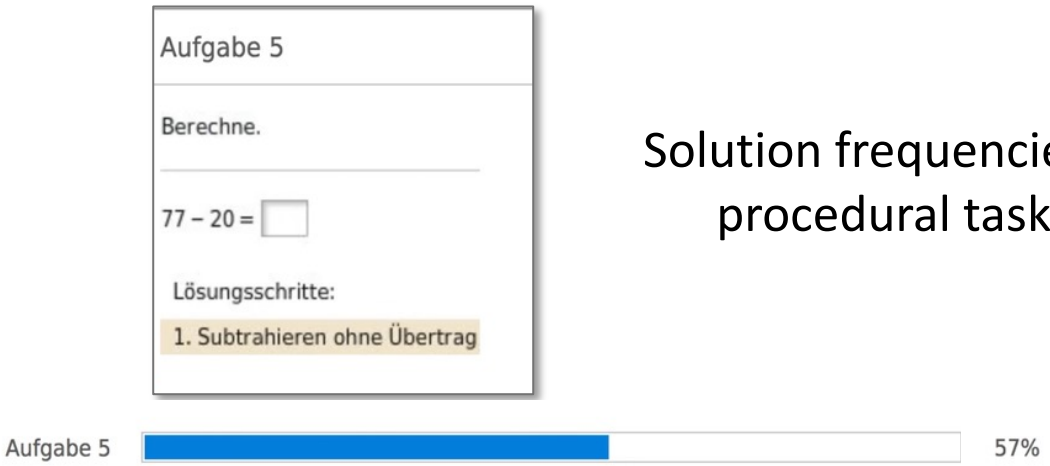
Student focus & adaptivity:
Work with student perspectives

Diagnosis often just as percentages of correctly solved tasks





Encouragement to repeat the same tasks



Solution frequencies of procedural tasks

Digital diagnostics in Germany

Student focus & adaptivity:
Work with student perspectives

bettermarks®
ERFOLGREICH MATHE LERNEN

ANTON

Mathegym
Mathe-Online-Training

Focus on procedures
Diagnosis often just right or wrong

Intensifies current problems in Mathematics Teaching:
- Focus on procedures
- Superficial Diagnosis

SMART
Specific Mathematics Assessments that Reveal Thinking

KULTUSMINISTER KONFERENZ

Focus on understanding
Diagnosis of levels of understanding, misconceptions & hints for individual support

Offers Hints to overcome current problems in Mathematics Teaching:
- Understanding
- Deep Diagnosis
- Professionalisation of teachers

Thurm & Graewert 2022, Thurm 2021

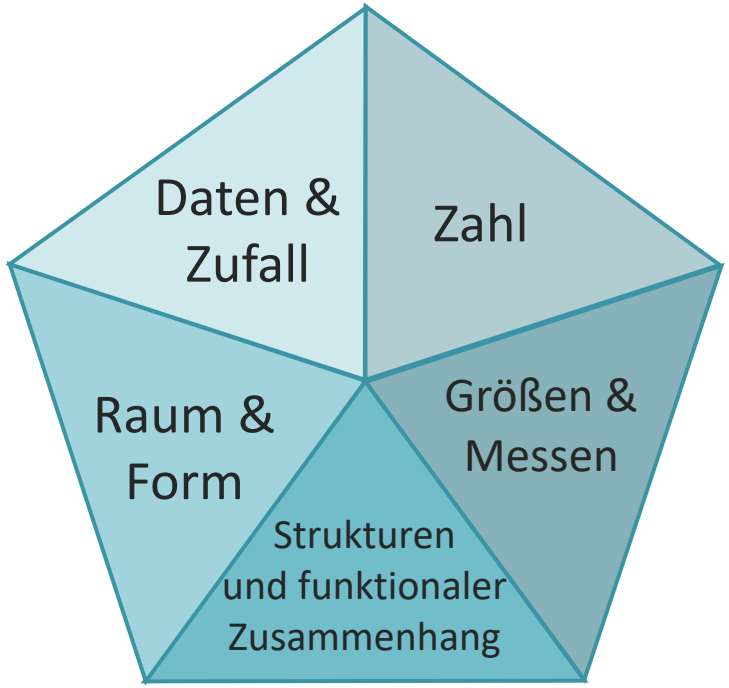
Digital diagnostics in Germany

Student focus & adaptivity:
Work with student perspectives

SMART

SMART is a project of the University of Melbourne (Kaye Stacey) since 2008
Cycles of Research-based design with investigating more than 500.000 students‘ solutions

About 130 Tests (every 5-10 min) in 5 areas & 65 topics
For teachers and their spontaneous practices during teaching



Digital diagnostics in Germany

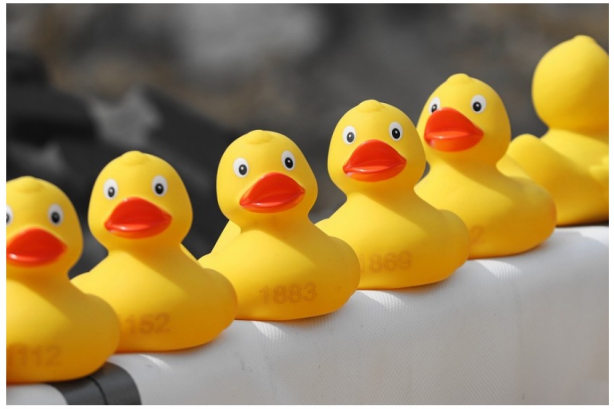
Student focus & adaptivity:
Work with student perspectives

SMART

Illustrative example: Meaning of letters

SMART Deutsches Zentrum für Lehrkräftebildung Mathematik

0%



Lucy hat 6 Enten für insgesamt 12 Euro gekauft.

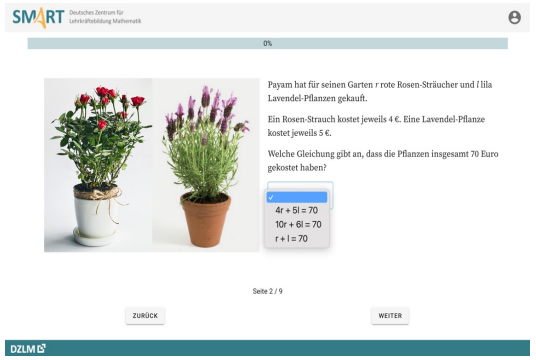
Sie hat folgende Gleichung aufgeschrieben: $6e = 12$.

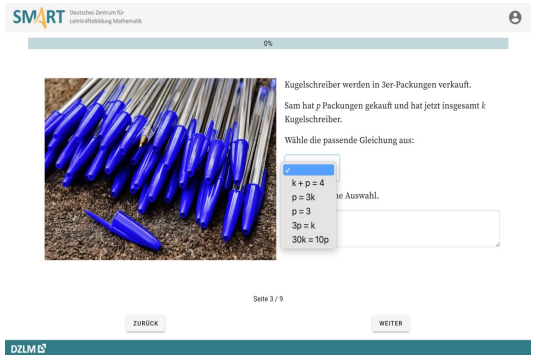
Wofür steht das e in Lucys Gleichung? e steht für:

- Enten
- eine Ente
- den Preis einer Ente
- Euro

Seite 1 / 9

WEITER





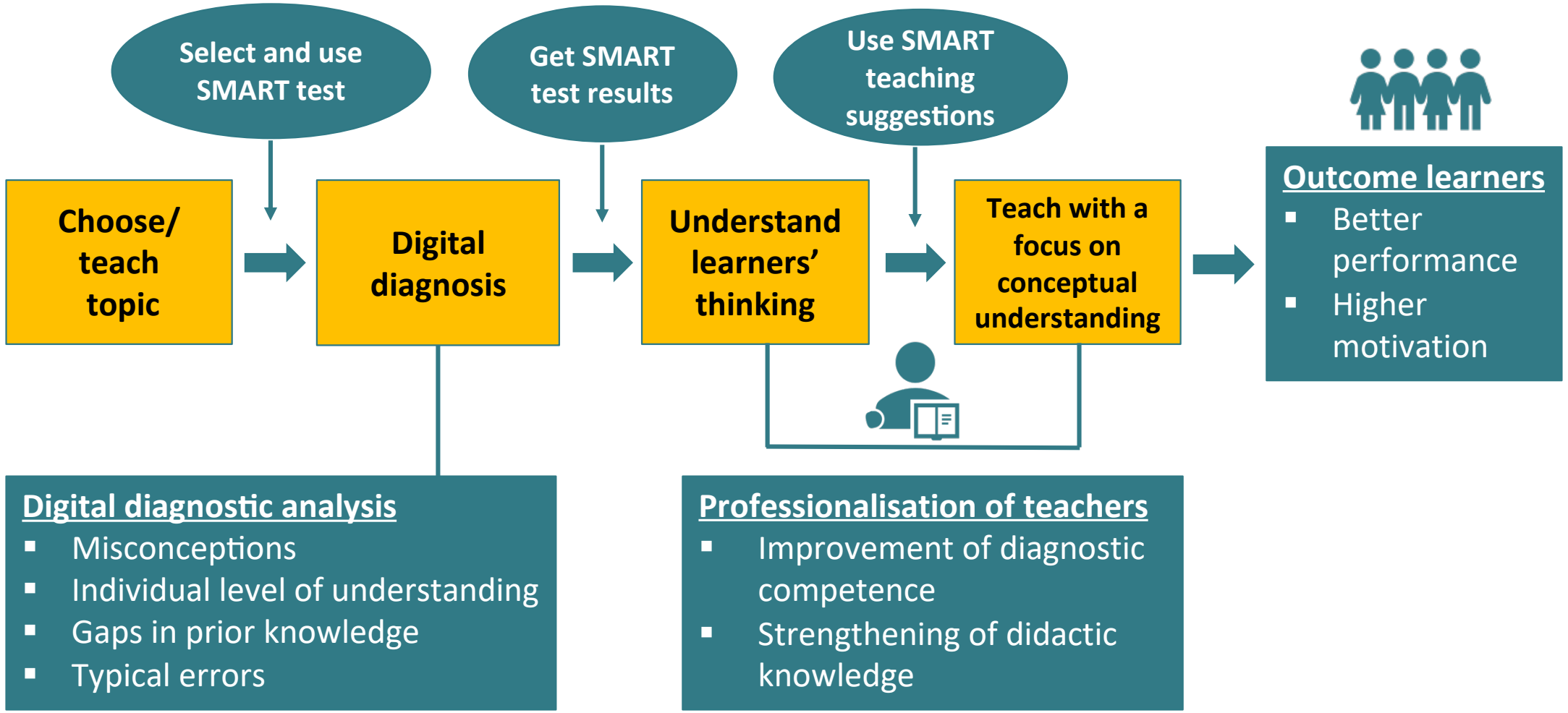
DZLM

Klingbeil et al. (acc)

Digital diagnostics in Germany

SMART

Student focus & adaptivity:
Work with student perspectives



Stacey et al. 2018

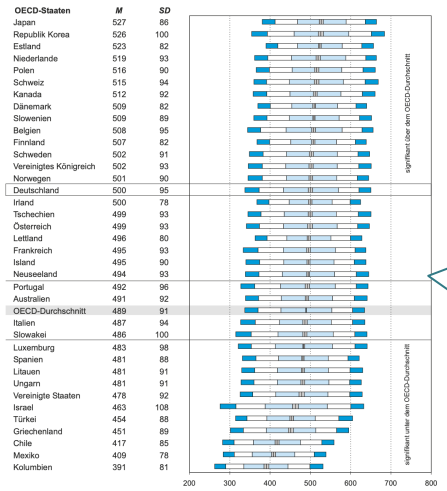
Revised National Standards for Mathematics:

The story

KULTUSMINISTER KONFERENZ

IQB: Institut zur Qualitätsentwicklung im Bildungswesen

New challenges



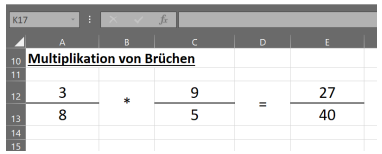
Two thirds of 8th graders in Germany say they never work with media in MU

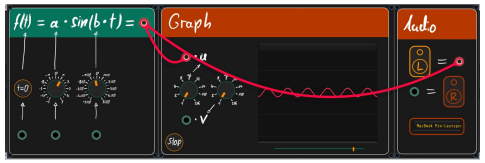
Illustrative Examples

- **Cognitive demand:** Initiate active learning processes
- **Focus on understanding:** of concepts, strategies and procedures
- **Longitudinal coherence:** Prepare for sustainable learning
- **Student focus & adaptivity:** Work with student perspectives
- **Enhanced communication:** Talk about mathematics

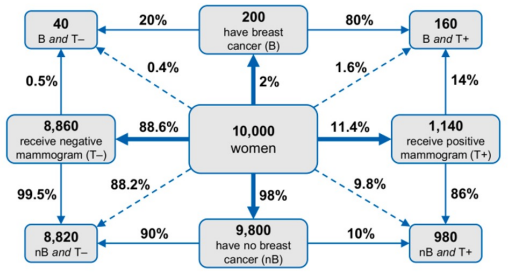
Space and Shape

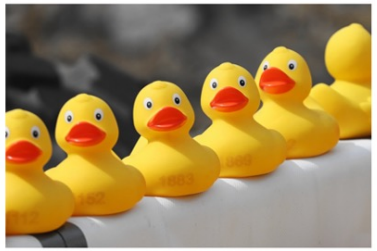
Structures and functional dependency





Data and Chance





SMART

QuaMath

Pictures from IQB

Many thanks four your attention!

Bärbel Barzel, University of Duisburg-Essen

Literature

Binder, K., Steib, N. & Krauss, S. (2022). Von Baumdiagrammen über Doppelbäume zu Häufigkeitsnetzen ? kognitive Überlastung oder didaktische Unterstützung? *Journal für Mathematik-Didaktik*, 739. doi: 10.1007/s13138-022-00215-9

Binder, K., Krauss, S., Schmidmaier, R., & Braun, L. (2021). Natural frequency trees improve diagnostic efficiency in Bayesian reasoning. *Advances in Health Sciences Education, 26*(3), 847-863. doi: 10.1007/s10459-020-10025-8

Binder, K., Krauss, S., & Wiesner, P. (2020). A new visualization for probabilistic situations containing two binary events: The frequency net. *Frontiers in Psychology*, *11*(750). Zum Artikel; Pressemitteilung zu diesem Artikel

Drijvers, P., Thurm, D., Vandervieren, E., Klinger, M., Moons, F. & van der Ree, H. (2021). Distance mathematics teaching in Flanders, Germany, and the Netherlands during COVID-19 lockdown, Educational Studies in Mathematics 108 (1-2), 35-64

Göbel, L. (2021). Technology-assisted Guided Discovery to Support Learning - Investigating the Role of Parameters in Quadratic Functions. Wiesbaden: Springer-Spektrum.

Klingbeil, L., Barzel,. B., Schacht, F., Stacey, K., Steinle, V. & Thurm, D. (accepted) . The potential of multiple-choice items for assessing students' conceptions of algebraic letters with SMART online diagnosis. ZDM

Stacey, K., Steinle, V., Price, B., & Gvozdenko, E. (2018). Specific mathematics assessments that reveal thinking: An online tool to build teachers' diagnostic competence and support teaching. In T. Leuders, J. Leuders, K. Philipp, & T. Dörfler (Eds.), Diagnostic competence of mathematics teachers – Unpacking a complex construct in teacher education and teacher practice (pp. 241–263). Springer. https://doi.org/10.1007/978-3-319-66327-2_13

Steinle, V., Gvozdenko, E., Price, B., Stacey, K., & Pierce, R. (2009). Investigating students' numerical misconceptions in algebra. In R. Hunter, B. Bicknell & T. Burgess (Eds.), Crossing divides – Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia (Vol. 2) (pp. 491–498). MERGA.

Thurm, D. & Graewert, L. (2022). Digitale Mathematiklernplattformen in deutschland. Springer

Thurm, D., Vandervieren, E., Moons, F., Drijvers, P., Barzel, B., Klinger, M., van der Ree, H. & Doorman, M. (2023). Distance mathematics education in Flanders, Germany, and the Netherlands during the COVID 19 lockdown—the student perspective. ZDM - Mathematics Education, 55, 79–93. https://doi.org/10.1007/s11858-022-01409-8