Mathematical competences in workplace activities of trained retail salespeople (TRS) from different perspectives

(Short) **Presentation**

24th International Conference of Adults Learning Mathematics
(Rotterdam, 2 – 5 July 2017)

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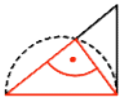
- Introduction
- Research Questions
- The Concept of *'Competence'*
- Mathematical Competences at Work: Two Perspectives
  - Vocational and Business Education
  - Mathematics Education
- Research Design
- Further Perspectives



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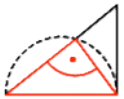
Mathematics in the Workplace

- inherent element of job requirements *(OECD, 2012; Seeber, 2013; Winther et al., 2013; Siebert & Heinze, 2016)*
- incorporated or integrated in workplace practice and situations *(cf. Kaiser, van der Kooij, & Wake, 2013; Wedege, 2010; Kent, Bakker, Hoyles & Noss, 2011)*
- hidden, implicit, invisibile *(cf. Hoyles, Noss, Kent & Bakker, 2010; Williams & Wake 2007; Bessot & Ridgway, 2000; Sträßer & Zevenbergen, 1996*
- subjected to ‚problem-oriented integration of concepts' *(Sträßer, 1996)*
- domain specific *(e.g. Sträßer, 2015)*
- no common core of vocational mathematics *(Sträßer, 2015)*



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Research Questions

- From the perspective of **mathematics education** – which **mathematical requirements** can actually be identified in the professional every-day life of trained retail salespeople ?

- Which **mathematical competences** do trained retail salespeople use for coping with those vocational requirements?

- Is there an observable and possibly empirically provable connection between those mathematical requirements and competences, and the **job satisfaction** of trained retail salespeople?

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'Competence' in Research & Science

- Plethora of **theoretical approaches**

  (cf. Frey, & Ruppert, 2013; Mulder, Weigel, & Collins, 2006; Garavan, & McGuire, 2001)

  – generic, normative, & pragmatic *(e.g. Klieme, Hartig, & Rauch, 2010)*

  – generic, behaviourist, & cognitive *(cf. Eraut, 1994; Norris, 1991; Mulder, Weigel, & Collins, 2006; Norris, 1991; Wesselink, et al, 2005)*

  – generic, behaviourist, & holistic *(Gonczi, 1994)*

  – generic, behaviourist, rationalist, constructivist, interpretative, & functional *(Le Deist, & Winterton, 2005)*

- **No widely accepted definition** of 'Competence'

  (cf. Sembill, Rausch, & Kögler, 2012; Weinert, 1999; Jones, & Moore, 1995)

'Competence' in Scientifically Related Disciplines

Social Sciences

Sociology

- Sociology of **Authority** *(Weber, 1922)*
- Sociology of **Knowledge** *(Dewey, 1922; Ryle, 1949; Polanyi, 1958)*
- **Action Theories** *(Parsons & Platt, 1973)*
  e.g. ‚Sociology of Expertise'
  ‚Synergetics' *(Haken, 1960s)*

Paedagogy

- **Constructivist** Approach *(Maturana & Varela, 1984)*
- **Critical-Constructive Didactics** *(Klafki, 1985)*
- **Action Theory** *(Roth, 1971)*
  - **self**-competence
  - **professional** competence
  - **social** competence

Psychology

- **Activity Theory** *(Vygotsky, Leont'ev, 1930s)*
- **Competence** as …
  - **basic need** & **intrinsic motivation** *(White, 1959; Deci & Ryan, 1991)*
  - **ability to master ones life** *(Seligmann, 1967; Bandura, 1971)*
  - effective engagement with the social environment *(Mc Clelland, 1973)*
  - **disposal of skills** *(Weinert, 2001)*

Linguistics

- ***Linguistic** Competence* *(Chomsky, 1920)*
  Competence vs. Performance
  (Goffmann, Dell Hymes, Austin, Vygotski)
- ***Communicative** Competence* *(Habermas, 1981)*

Competence

selected key aspects:
- **situated**
- **contextualised**
- **action-oriented**

selected key aspects:
- **cognitive**
- **universal applicable**

Vocational Education

Mathematics Education

Educational Research

Philosophy

Epistomology

… (others)

‚Kompetenz' in Germany

- ***‚Kompetenz'* statutorily specified**

  Vocational **education**: **Vocational Action Competence**

  KMK (2014): ‘Berufliche Handlungskompetenz’

  General **education**: KMK (2004)

  - **Competence**
    ‘Kompetenz’ (according to Franz Weinert)
    related to a specific school-subject/domain
  - **Mathematical** Competences
    ‘Bildungsstandards Mathematik’

‚Kompetenz' in Germany

- **Different concepts** of *‚Kompetenz'*

  Vocational **education**: **Vocational Action Competence**
  - contextualized
  - action-oriented
  - defined by domain-specific situations

  General **education**:
  - **Competence**
    - cognitive
    - universal applicability
  - **Mathematical** Competences (‘at work’)
    - rarely explicitly conceptualised

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The German Dual System of Vocational Education and Training

- **'Dual System'**: 1. company-based apprenticeship
  combined with 2. part-time vocational school *(KMK, 2014)*

- Well-**developed**, deeply **embedded**, and widely **respected** in German society *(OECD, 2011; KMK, 2014)*

- Offers qualifications in a **broad spectrum of professions**
  (currently around 330 so called "recognized occupations requiring formal training")

- Aim: Acquirement of **Vocational Action Competence**

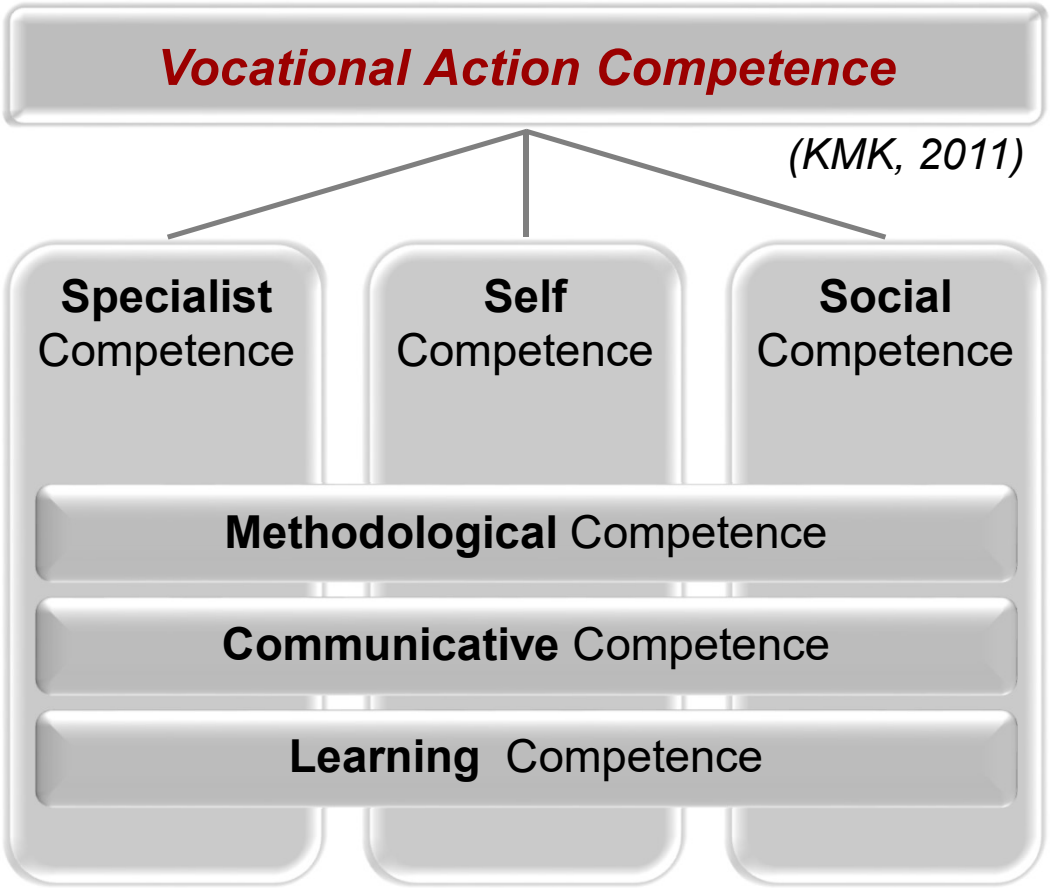
  *'Training in recognized occupations requiring formal training … is directed at the acquisition of **vocational competence** … ."* *(KMK, 2014; p.115)*

Mathematical Competence *as Part of* ***Vocational Action Competence***

- Vocational Action Competence
  - normative conception
  - formulated in general language
  - action-oriented
  - contextualized
  - domain-specific contents

  (Winther, Sangmeister & Schade, 2013)

Mathematical Competences
('at work')
- domain-specific !



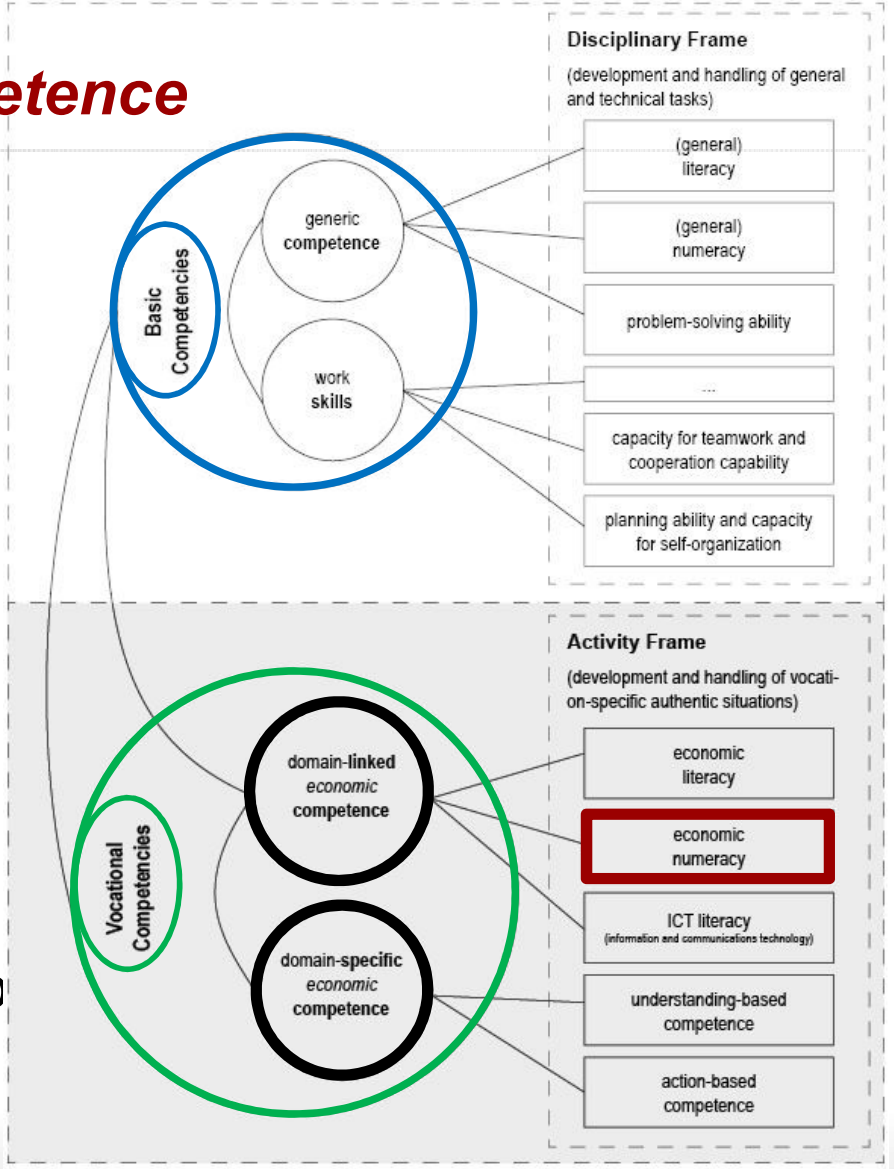
Integrative Model of Commercial Competence

(Winther, 2009)

- **basic** competencies
  vocational competencies

- **domain-linked** *economic competence*
  domain-specific *economic competence*

- **economic numeracy**
  as part of the domain-linked economic co



Economic Numeracy

(Winther, 2009)

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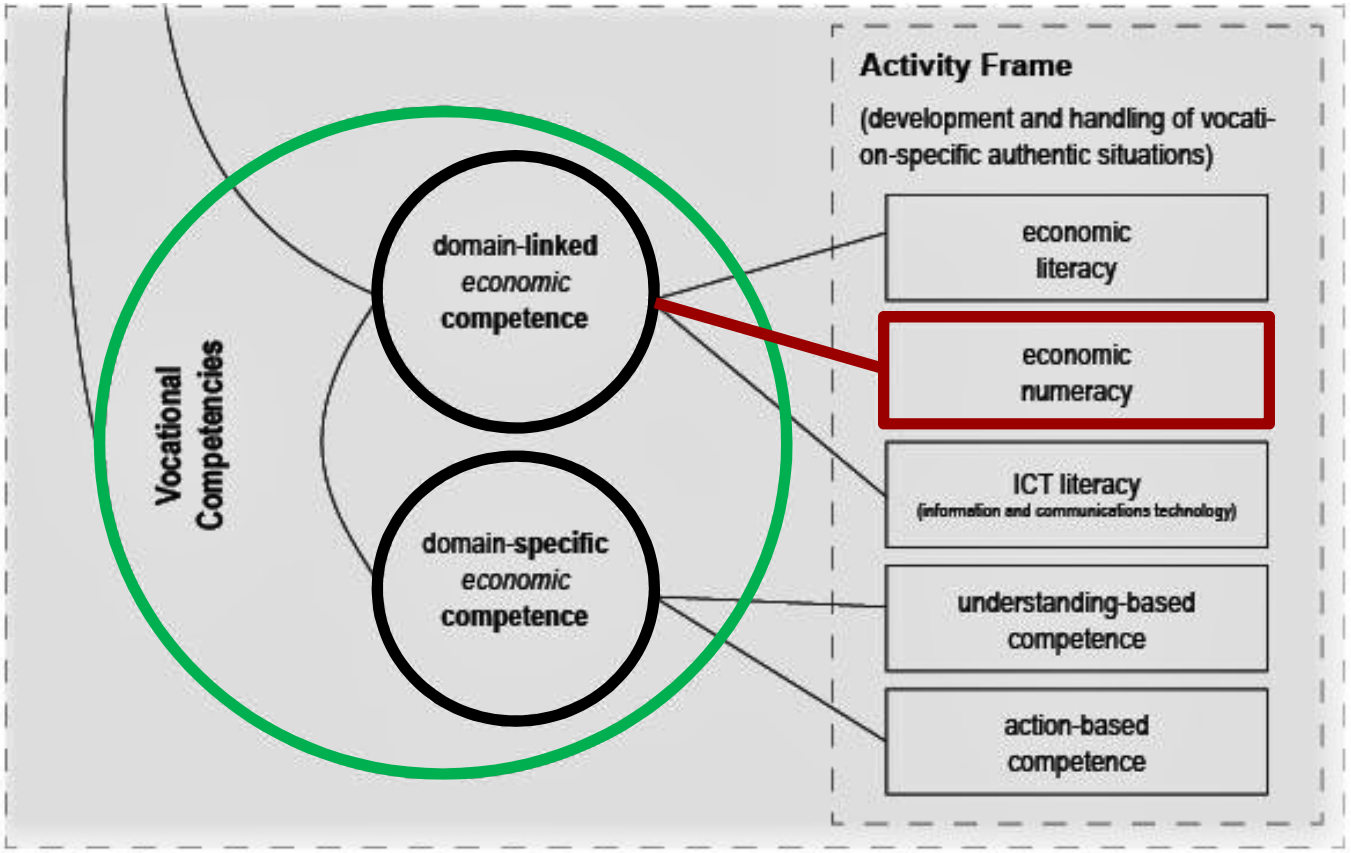
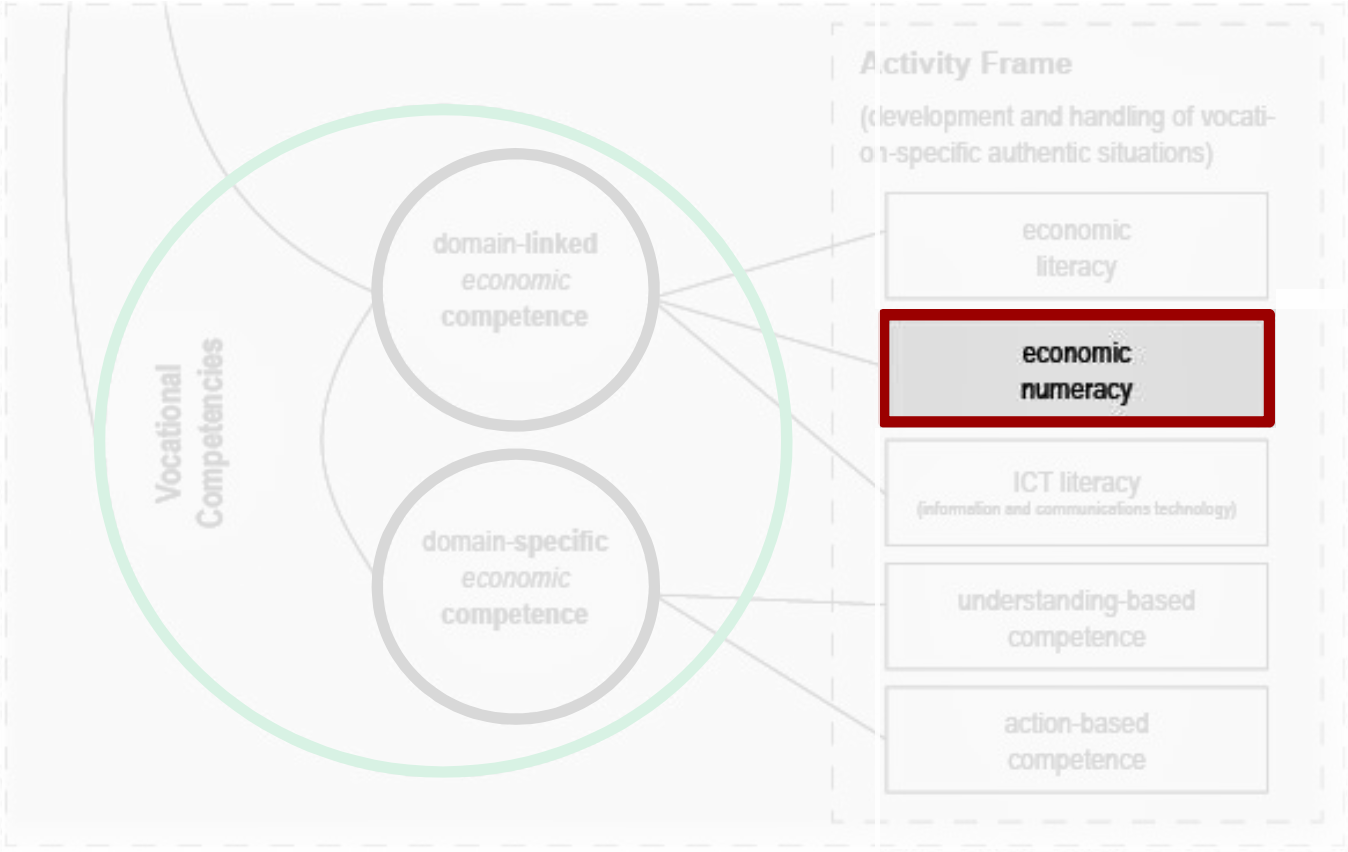


- **economic numeracy**
  as part of the domain-linked economic competence

Economic Numeracy

- **basic** mathematical **knowledge** & **skills**
- ‘economic calculation‘



- equivalent (?) to ‚**domain-related mathematical competence**‘
- (see Neumann

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Mathematical Competences in German Education Standards

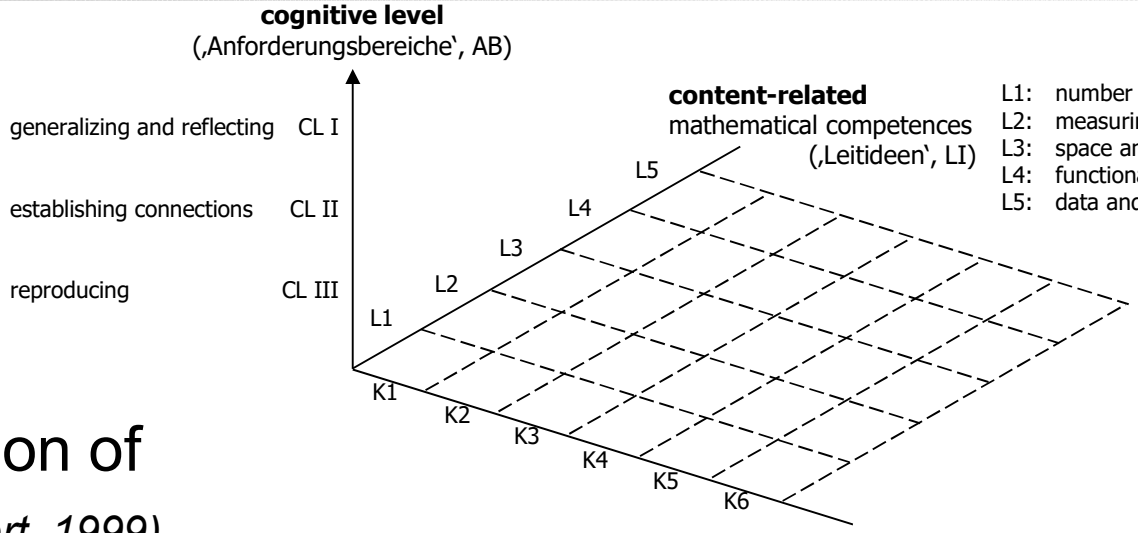
- **Competence**
  - Cognitive understanding

> *Competences are „those cognitive abilities and skills, motivational, volitional, and social dispositions and abilities that are needed for the process of problem solving in variable situations.“*
>
> *(Weinert, 2001, pp. 27-28)*

Mathematical Competences in German Education Standards

- **Competence**
  - Cognitive understanding (following (Weinert, 2001, pp. 27-28)
- **Mathematical** Competences
  - one part of general education
  - made concrete in German Mathematics Education Standards ('Bildungsstandards im Fach Mathematik')
- German (Mathematics) **Education Standards** *(KMK, 2014, 2005, 2004)*
  - specify general educational objectives as competences
  - (by a) normative structure model of competence

*Mathematical Competences in German **Mathematics** Education Standards*



- **Normative** specification of competences *(Weinert, 1999)*
- 5 **content–related** mathematical competences
- 6 **general** mathematical competences comprising **cognitive processes**
- 3 **cognitive levels**

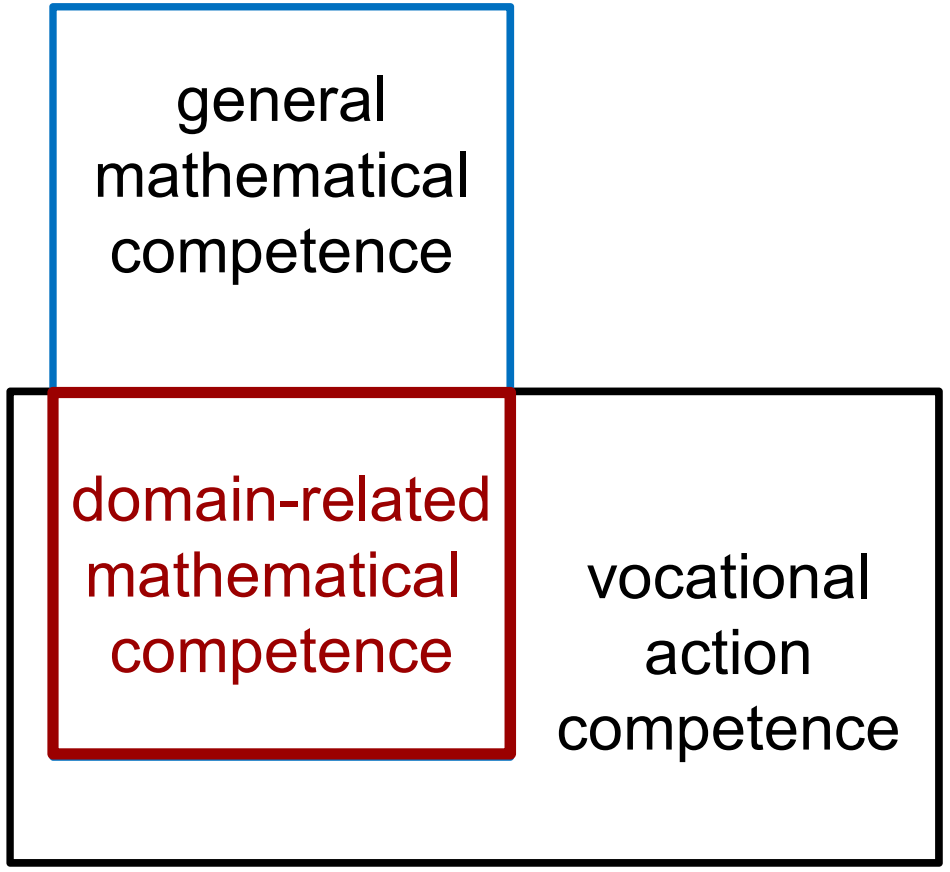
general mathematical competences comprising **cognitive processes**
(‚Kompetenzen', K)

- K1: mathematical argumentation
- K2: mathematical problem solving
- K3: mathematical modeling
- K4: use of mathematical representations
- K5: dealing with symbolic, formal, and technical elements of mathematics
- K6: mathematical communication

Neumann et al. (2013a). Modeling and assessing mathematical competencies over the lifespan

Domain-Related Mathematical Competence

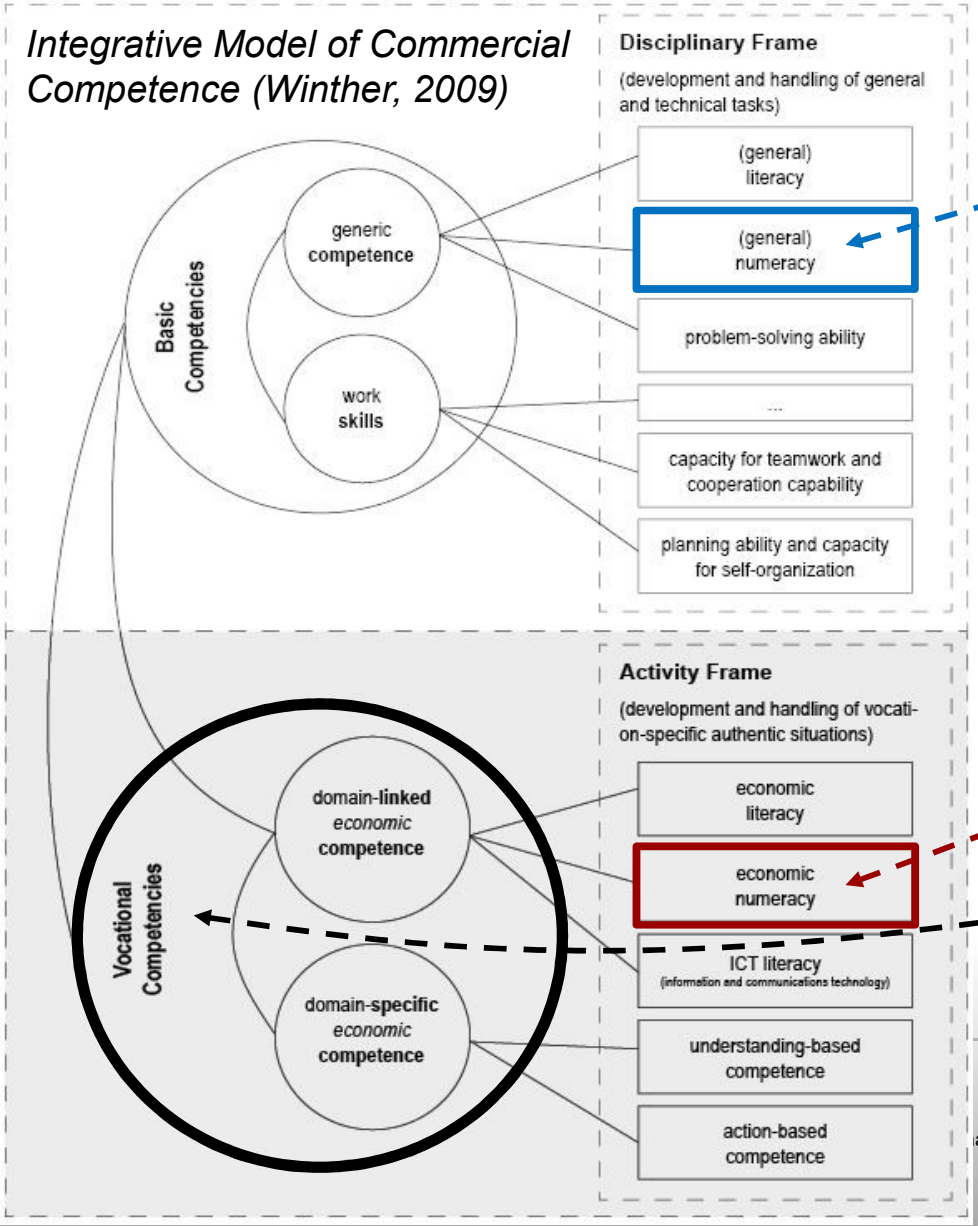
- part of those mathematical competences acquired at school
- **applied functionally** in specific vocational tasks
- empirically **distinguishable** from **general mathematical** competences
- equivalent (?) to the term of '**economic numeracy**' (as per Winther, 2009)



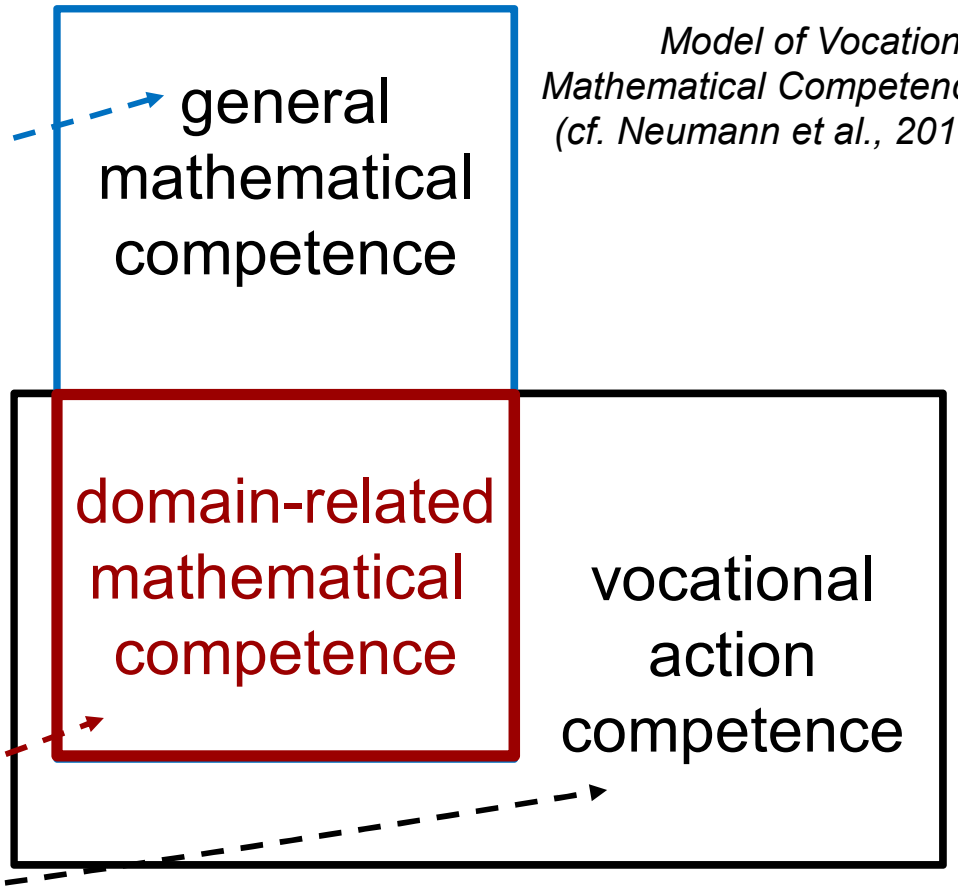
(cf. Neumann et al., 2013b)

Domain-Related Mathematical Competence & Economic Numeracy

Integrative Model of Commercial Competence (Winther, 2009)



Model of Vocational Mathematical Competence (cf. Neumann et al., 2013)



Domain-Related Mathematical Competence & Economic Numeracy

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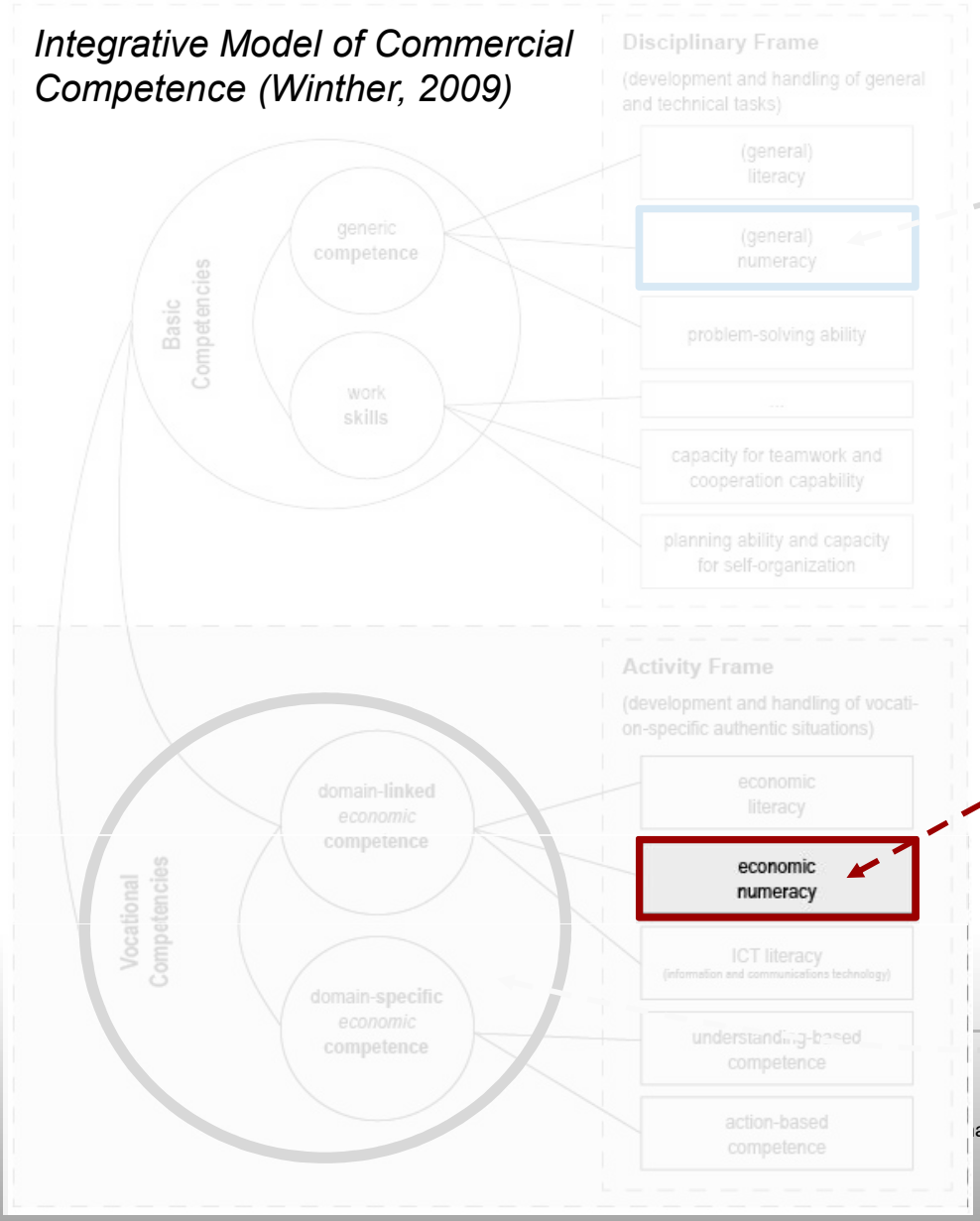

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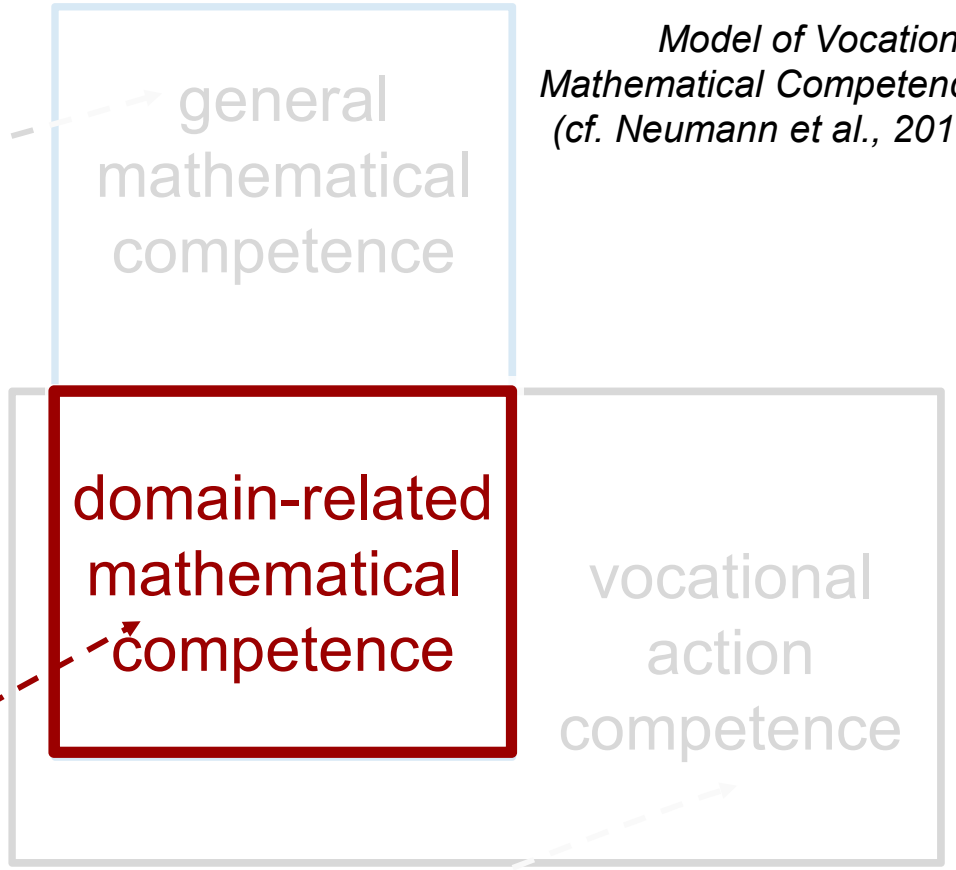
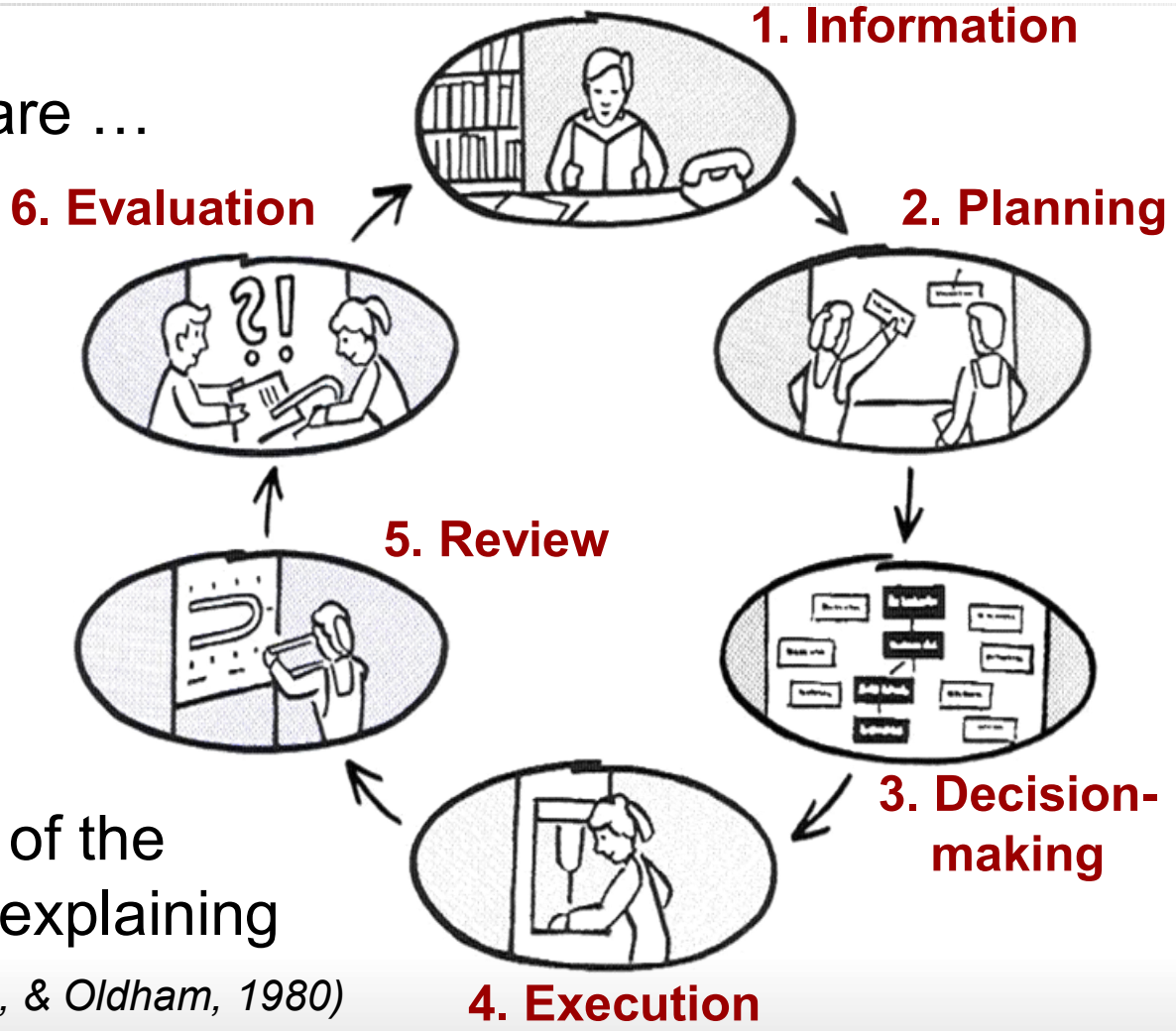


***Principle** of a '**Complete Vocational Action**'*

'Complete vocational actions' are …

- **action processes**
- basis for **VET-training modules**
- '**ideal conception**' in VET
  (Klieme, & Hartig, 2007)
- (as '**task Identity**') one part of the 'model of job characteristic' explaining i.a. **job satisfaction** *(Hackman, & Oldham, 1980)*



Mathematical Competences in a '*Complete Vocational Action*'

Complete Vocational Action

Planning → Decision-making → Execution → Review → Evaluation

Vocational Perspective

Mathematical Perspective

Situation in the workplace	**Situation** in the workplace	**Situation** in the workplace	**Situation** in the workplace	...	**Situation** in the workplace
mathematical **competences**: • requirements • contents • processes	mathematical **competences**: • requirements • contents • processes	mathematical **competences**: • requirements • contents • processes	mathematical **competences**: • requirements • contents • processes		mathematical **competences**: • requirements • contents • processes

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Research Questions (Reminder)

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- Which **mathematical competences** do trained retail salespeople use for coping with those vocational requirements?

- Is there an observable and possibly empirically provable connection between those mathematical requirements and competences, and the **job satisfaction** of trained retail salespeople?

Methodological Approach

- Theoretical part:
  - **Documentary Analysis**

- Empirical part:
  - **Expert Workshops**
  - **Ethnographic Observations**
  - **Interviews** & **Questionnaires**
  - **Computerized Assessment** of **Mathematical Competences**

i.a. partly based on strands within the concepts of

activity theory *(cf. Leont'ev, 1978)*
situated abstraction *(cf. Noss & Hoyles, 1996)*
and ***situated cognition*** *(cf. Lave, 1988; Lave & Wenger,1991)*

Theoretical Part: ***Documentary Analysis***

Aim: Identification of mathematical contents in vocational training as described in official publications

- **Qualitative Content Analysis** *(Mayring, 2008)*
  of curricula, textbooks, and training regulations *(KMK, 2004)*
- **Rational Tasks Analysis** *(see Hoffarth, 2009)*
  of recruitment tests and final examinations

Empirical Part: ***Expert Workshop 1***

Aim: Development of an **observational protocol** of **typical situations** in the professional everyday life of a trained retail salesperson (TRS) and their mathematical requirements.

- 10-12 **currently employed TRS**
- 3-5 years **working experience**
- Step 1: Identification and description of **typical situations**
  Step 2: Identification of **mathematics** in those typical situations

Empirical Part: ***Expert Workshop 2***

Aim: Development of an **observational protocol** of **typical situations** in the professional everyday life of a trained retail salesperson (TRS) and their mathematical requirements.

- 10-12 **future vocational school teachers**, ideally TRS

- Description of **mathematical competences** pertaining to the typical situations identified in workshop 1 in terms of the German **educational standards**

*Empirical Part: Ethnographic **Observations** (Shadowing & Interviewing)*

Aims: Description of **mathematical competences** pertaining to real work activities of TRS and Validation of the observation protocol

Pilot study:

- 1 experienced TRS; several visits

Main study:

- 4-6 TRS, 3-5 years working experience
- Several visits and intended total duration approx. 30 hrs (each TRS)
- Field notes structured by observation protocol, audio/exemplary video recordings, copies of resources

Empirical Part: ***Interviews*** *&* ***Questionaires***

- **Interviews** on …
  - previous observations
  - subjectively perceived frequency of occurrence of ‘complete vocational action’ and of subjectively perceived ‘success’ (in these)
  - subjectively perceived ‘mathematical competence’

- **Questionnaire** on ‚job satisfaction‘

Empirical Part: ***Computerized Assessment*** *of* ***Mathematical Competence***

- '**MaK-adapt**' (cf. Prof. Frey, 2011):

  Differentiated assessment of mathematical competence with multidimensional adaptive testing in the commercial context

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Further Perspectives

- Development of an **instrument to measure** those mathematical competences which are needed for vocational tasks.

- Do the **mathematical competences** of a retail salesperson **match** the mathematical **requirements** in their daily work?

- **Skill mismatch** is assumed to have an impact on **job satisfaction**

Thank you!

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