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)
Contents

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

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

- hidden, implicit, invisible  
  (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)
Contents

- Introduction
- Research Questions
  - The Concept of ‘Competence’
  - Mathematical Competences at Work: Two Perspectives
    - Vocational and Business Education
    - Mathematics Education
- Research Design
- Further Perspectives
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?
Contents

- Introduction
- Research Questions
- The Concept of 'Competence'
- Mathematical Competences at Work: Two Perspectives
  - Vocational and Business Education
  - Mathematics Education
- Research Design
- Further Perspectives
‘Competence’ in Research & Science

- Plethora of theoretical approaches
  - generic, normative, & pragmatic
    (e.g. Klieme, Hartig, & Rauch, 2010)
  - generic, behaviourist, & cognitive
  - 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

**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)

**Social Sciences**

**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 own 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
- Epistemology
- … (others)
'Kompetenz' in Germany

- 'Kompetenz' statutorily specified
  - **Vocational education:** Vocational Action Competence
    - KMK (2014): 'Berufliche Handlungskompetenz'
  - **General education:**
    - 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
Contents

- Introduction
- Research Questions
- The Concept of ‘Competence’
- Mathematical Competences at Work: Two Perspectives
  - Vocational and Business Education
  - Mathematics Education
- Research Design
- Further Perspectives
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: Acquisition 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 competence
Economic Numeracy

(Winther, 2009)

- basic competencies
- vocational competencies
- domain-linked economic competence
- domain-specific economic competence
- 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)
Contents

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

---

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)

Disciplinary Frame
- (general) literacy
- (general) numeracy
- problem-solving ability
- capacity for teamwork and cooperation capability
- planning ability and capacity for self-organization

Activity Frame
- economic literacy
- economic numeracy
- ICT literacy (information and communication technology)
- understanding-based competence
- action-based competence

Vocational Competencies
- domain-linked economic competence
- domain-specific economic competence

Generic Competence
- work skills

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

- general mathematical competence
- domain-related mathematical competence
- vocational action competence
Domain-Related Mathematical Competence & Economic Numeracy

Integrative Model of Commercial Competence (Winther, 2009)

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

1. Information
2. Planning
3. Decision-making
4. Execution
5. Review
6. Evaluation
Mathematical Competences in a ‘Complete Vocational Action’

Complete Vocational Action

Planning → Decision-making → Execution → Review → Evaluation

Vocational Perspective

Situation in the workplace

Mathematical Perspective

mathematical competences:
- requirements
- contents
- processes

mathematical competences:
- requirements
- contents
- processes

mathematical competences:
- requirements
- contents
- processes

mathematical competences:
- requirements
- contents
- processes

...
Contents

- Introduction
- Research Questions
- The Concept of ‘Competence’
- Mathematical Competences at Work: Two Perspectives
  - Vocational and Business Education
  - Mathematics Education
- Research Design
- Further Perspectives
Research Questions (Reminder)

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

• 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)
- 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 & Questionnaires

- **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
Contents

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

- Further Perspectives
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!

schallmaier@math.uni-bremen.de