# The language of graphs and tables



8 October 2019, 10:00-11:00 (KA 102) Utrecht University, Freudenthal Institute Monica Wijers, Vincent Jonker







## Content

- Starter
- The project
- Language of tables and graphs
  - Pretest Student difficulties and pre-test
  - Worksheets and examples
- Vocational setting
- Professional development



BZ-Grafik/ja

QUELLE: STADT FREIBURG



### Der Gemeinderat in Freiburg



# The Project LaMavoc



Language for Mathematics in Vocational Contexts

### LaMaVoc

Developing a teaching approach and respective teaching units for workplace-related and language-integrated mathematics learning on the mathematical topics fields of percentages, proportional reasoning and graphs/tables for vocational classes in the technical and agricultural sector.

# Organisation

- Three countries: Germany, Sweden, the Netherlands
- Teacher trainers, researchers and teachers from vocational education
- Target group: 'low achievers'
- 3 year project
- Teaching materials Graphs & Tables, Proportions and Percentages
- PD materials

## Issues to deal with

Between NL and DE

- Differences between school systems, levels and curricula
- Differences in pedagogical (didactical) approaches, models and tools
- Language differences (related to mathematical concepts) Within NL
- differences between schools
- time constraints (for teachers in class and related to PD)
- Language sensitive teaching is new (as well as some of the pedagogical approaches)

Language of tables and graphs

# Student difficulties

### Difficulties in general

- Mathematical understanding of 'relations', patterns; etc.
- 'Graph as picture'
- 'Academic (mathematical) language of representations
- Vocational language related to language of representations



# ●₽₽ ②

#### More pigs, less farms

Number of pig farms x 1000



Average number of pigs

per farm x1000

## About how many pigs did Noord Brabant have in 2015 according to the graphs

- 1750 000 varkens
- 3 750 000 varkens
- 5 250 000 varkens
- 12 500 000 varkens
- 17500000 varkens

#### written language

Combination of text and graphs, 'visuals' and numbers

Mathematical language: symbols 'x 1000', large numbers. Concept: reading and combining 2 double bar graphs (vertical scales differ).

General academic language: 'on average', 'per', legenda,

# pre-test using general contexts

2018 tested in (pre)vocational classes

# Student work

93 students

- Nordwin 33 pre-vocational (16 grade 8 / 17 grade 7)
- ROC Nijmegen 26 vocational (first year, grade 11)
- Wellant 34 (16 grade 9 / 18 grade 10)

# 1 – reading information from a graph & story



Bob takes a bath. First he opens the warm water tap, for the first five minutes. He then realises the water will be too warm and he opens the cold water tap. The graph shows the relation between time and amount of water in the bathtub.

- What kind of information is presented at the vertical axis?
- When the cold water tap opens the tub will load faster. How can you see this?
- At what time the cold water tap is opened?
- After some time the plug is removed. How can you see this in this graph? At what time?

# 2 – Matching graph & title





- 1. Length of a man during his life
- 2. Temperature during a day
- 3. Height of weed over several years
- 4. Sea level during a day
- 5. Height of water in plastic bottle with a hole in the bottom
- 6. Your bicycle route from home to school



Option 2 Temperature during a day

Bogint Rude meddages worn en hvelt dan Rustig af

Quiet start and warm in the afternoon, and then cooling down quietly

В



1. Length of a man during his life

Good heel mel on pas leat Krimpt die

Grows very fast and only late he shrinks



1. Sea level during a day

conspustiges sons golvers

Somtimes quiet and sometimes waves



Height of weeds over several years

voellyroot en dan moein Zo het is een

Becomes big and then they trim it again

# 3 – Interpreting a 'real' bar-graph

#### Doubling the sweet cherry production in the last fifteen years

Growth (in hectares) of sweet cherry cultivation (1 hectares is  $100 \text{ m} \times 100 \text{ m} = 10.000 \text{ m}^2$ )



Is the statement frm the title correct? Explain how you can see this in this graph.

This is a graph from a newspaper. Write down three sentences that tell what the graph is about.

# 4 – Drawing a graph for a story

speed

Nick gets on his bike and starts a ride from his home.

Then he rides along the street with constant speed before it carves up a hill.

On top of the hill, he pauses for a few minutes to enjoy the view. After that he drives back down and stops at the bottom of the hill.

Draw a graph to show how his speed changes as a function of the time

time





tempo Luim well pause au tempo Luim well pause au ichau russis sig acceleratic

acceleration | constant speed | hill climb. | break. | down hill | constant speed | school

# Unit: Language of tables and graphs

Unit with worksheets and teacher notes

# Some design principles

Contexts

- 'familiar' enough to talk about
- connected to meaningful math

Interaction

- between students cooperative learning
- between teacher and students -> scaffolding language (and understanding)

Supporting language and improving mathematical understanding

• text frames

- exemplary (lists of) words and expressions
- supporting mathematical reasoning (by e.g scaffolding)

# Four 'phases'

	Learning strand Graphs/diagrams/tables	Learning strand Language
1	Activate and re-use knowledge, by using common and vocational contexts	Emphasis on spoken interaction, by using different kinds of language: common, school, vocational and mathematics related.
2	Combine different representations of graphs/diagrams/tables and make explicit the mathematical concepts	(Re-)introduce the language of graphs/diagrams/tables. Make an explicit connection of the mathematical concepts with the world of work/school/home
3*	Practice the use of different representations and their connections. Broaden the number and type of representations (including a stronger relation with functions	Practice the school language of mathematics and the strong connection with the world of work
4*	Apply knowledge and skills in situations (partly new), with support for problem solving en reasoning	Apply knowledge and skills in the world of work, in more complex situations

#### Look at the diagram below together.



Discuss and answer the following questions

- What do you call this type of diagram?
- Explain to your neighbour what the diagram is about.
- Come up with a fitting (short) title for this diagram.
- Circle the right word, so that the sentence matches the diagram:

Most ...old/young...... worms can be found in ...sand/peat..... without/under a cowpat

Cowpats are ...good/bad..... for worms.

Number of worms per m<sup>2</sup>

blue: Young worms Red: Adult worms

Columsn: Sand: Without cowpat Under cowpat Peat: Without cowpat Under cowpat





# Two examples of worksheets

in everyday contexts

### Number of goats in the Netherlands (2000-2018)



Discuss and answer the following questions What is the graph about? What do you notice?

Tell the story that goes with the graph.

Record your story with your mobile phone.

Listen to the stories in pairs and discuss them together. Which are the most important words in your story?

Write them down below.

### Water temperature of the North Sea



## REFLECTION

• add 'purpose' to realise rich comunicative practices

# Vocational contexts

purpose, role, meaning

### Issues

• How to embed authentic vocational practices?

Variety across sectors (and levels)

More tables than graphs

Only 'reading values'

- Jobs with less responsibility -> less graphs
- Is writing a necessary skill for our target group?
- How far should we go into the mathematics of 'line-graphs'?

# Graphs and tables in vocational contexts

- More tables, than graphs
- Mainly reading of a single value
- Jobs with not so much responsibility -> seem to make less use of graphs

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1,6	0,35	1,321	1,25
1,8	0,35	1,521	1,45
2	0,4	1,679	1,6
2,2	0,45	1,838	1,75
2,5	0,45	2,138	2,05
3	0,5	2,599	2,5
3,5	0,6	3,010	2,9
4	0,7	3,422	3,3
4,5	0,75	3,878	3,7
5	0,8	4,334	4,2
6	1	5,153	5,0
7	1	6,153	6,0
8	1,25	6,912	6,8
9	1,25	7,912	7,8
10	1,5	8,676	8,5
11	1,5	9,676	9,5
12	1,75	10,441	10,2
14	2	12,210	12,0
16	2	14,210	14,0
18	2,5	15,744	15,5
20	2,5	17,744	17,5
22	2,5	19,744	19,5
24	3	21,252	21,0
27	3	24,252	24,0
30	3,5	26,771	26,5
33	3,5	29,771	29,5
36	4	32,270	32,0
39	4	35,270	35,0
42	4,5	37,799	37,5
45	4,5	40,799	40,5
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	1,8	0,35	1,521	1,45		
	2	0,4	1,679	1,6		
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	3	0,5	2,599	2,5		
	8	1,25	6,912	6,8		
	9	1,25	7,912	7,8		
	10	1,5	8,676	8,5		
	11 12	1,5 1,75	9,676 10,441	9,5 10,2 12,0		



-		Spanning (bar)			
		Normaa	l gebruik	Vol belas	t/Snelweg
Automerk en type	Bandenmaat	Voor	Achter	Voor	Achter
FORD					
COURRIER (10.96→00)					
1.3 / 1.8D	165/70 R 13	2.4	1.8	2.4	2.8
ESCORT (01.95→08.00)					
1.4, 1.8	175/70 R 13 - 185/60 R 14	2,2	1.8	2.5	2.8
1.8D, TD	175/70 R 13 - 185/60 R 14	2.3	2.0	2.5	2.8
FIESTA					
alle types	165/70 R 13-175/65 R 14-185/55 R 14	2.1	1.8	2.5	2.8
FOCUS C-MAX					
alle types	195/65 R 15-205/55 R 16-205/50 R 17	2.1	2.3	2.4	2.8
FOCUS					
alle types	185/65 R 14 - 185/60 R 15	2.2	2.2	2,4	3.1
	195/55 R 15 - 215/40 R 17				
FUSION		-			
alle types	195/60 R 15-195/55 R 16	2.4	2.2	2.5	2.8
	195/55 R 16-195/60 R 15				
GALAXY					
2.0, Tdi	195/65 R 15 - 215/60 R 15	2.6	2.4	2.7	3.0
2,3	195/65 R 15	2.6	2.4	2.7	3.0
200	205/60 R 15 - 215/60 R 15	2.7	2.5	2.9	3.2
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alle types	165/65 R 13	2.1	1.8	2.5	2.5
	165/60 R 14	2.2	1.8	2.5	2.5
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1.8, 2.0	205/55 R 16 - 205/50 R 17	2.1	2.1	2.4	2.8
1,8	205/50 R 16	2.3	2.1	2.5	2.8
2.5 V6	205/50 R 16	2.6	2.2	2.7	2.8
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alle types	205/55 R 15 - 225/50 R 16	2.2	1.8	2.2	1.8
			-		

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Anemonen													5cm	5cm	z, h
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<u>Begonia's</u>						1							15cm	3cm	z, h*
<u>Blauwe druifjes</u>													5cm	3cm	z, h, s
<u>Cyclaam</u>													5cm	3cm	h, s*
<u>Dahlia</u>													25cm	5cm	z, h
<u>Freesia</u>													8cm	8cm	z, h
<u>Hyacinten</u>													15cm	15cm	z, h
<u>Sterhyacint</u>													4cm	6cm	z, h, s
<u>Boshyacint</u>													4cm	6cm	z, h, s
<u>Oosters</u> <u>sterhyacint</u>													7cm	5cm	z, h
<u>Vroege sterhyacint</u>													6cm	10cm	z, h, s
Indisch bloemriet													30cm	15cm	z
Irissen													10cm	6cm	z, h
<u>lxia (en)</u>													30cm	7cm	z
<u>Geluksklaver (en</u> )													5cm	5cm	z,h
<u>Gladiolen</u>													10cm	10cm	z
<u>Gloxina</u>													20cm	8cm	z,h*
Hondstand													5cm	5cm	h, s

#### green – plant outside orange – flowering time



# Our main direction now .....

- Meaningful communication situations/genre
  - Give advise
  - Explain common 'procedure'/artefact
  - Make a descion based upon graph/table/artefact
- Scrited podcast; written advice
- Everyday life and general vocational situations
  - Customer perspective
- Mathematics:
  - 'global interpretation' -> trend? Can this be correct? how are dats organized?

# For example

		Spanning (b			ar)		
generalized and a		Normaa	l gebruik	Vol belas	t/Snelweg		
Automerk en type	Bandenmaat	Voor	Achter	Voor	Achter		
FORD							
COURRIER (10.96→00)				-			
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FOCUS C-MAX							
alle types	195/65 R 15-205/55 R 16-205/50 R 17	2.1	2.3	2.4	2.8		
FOCUS							
alle types	185/65 R 14 - 185/60 R 15	2.2	2.2	2,4	3.1		
	195/55 R 15 - 215/40 R 17						
FUSION							
alle types	195/60 R 15-195/55 R 16	2.4	2.2	2.5	2.8		
-	195/55 R 16-195/60 R 15						
GALAXY							
2.0, Tdi	195/65 R 15 - 215/60 R 15	2.6	2.4	2.7	3.0		
2,3	195/65 R 15	2.6	2.4	2.7	3.0		
25.0	205/60 R 15 - 215/60 R 15	2.7	2.5	2.9	3.2		
KA		1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.		00.200	10/2303		
alle types	165/65 R 13	2.1	1.8	2.5	2.5		
	165/60 R 14	2.2	1.8	2.5	2.5		
MONDEO							
1.8, 2.0	205/55 R 16 - 205/50 R 17	2.1	2.1	2.4	2.8		
1,8	205/50 R 16	2.3	2.1	2.5	2.8		
2.5 V6	205/50 R 16	2.6	2.2	2.7	2.8		
2.0TDCi	205/50 R 16						
PROBE							
alle types	205/55 R 15 - 225/50 R 16	2.2	1.8	2.2	1.8		
		-					

 You are at a gas station and want to inflate your tyres with some more air.
You see this table.

. . . . . . . .

# Data collection and graphing by students



- Many students and teachers have short days or are free on mo, wo and fri
- We can see this is our graph

On Tuesday the BBL students of horeca are in school and on Thursday those of healthcare. They spend more money. The menu is the same each day

# PD

# Framework – landscape

### Prediger (2018)

Jobs for teachers in language-responsive math classrooms



### Jobs for teachers in language-responsive math classrooms

Five jobs	Noticing language	Demanding language	Sup lang	porting juage	Developing language
	Identifyir	ng mathematica	ally relev	ant langua	age demands
Pedaggogical Tools	Formative assessment too Dis pe	ols scursively activating edagogies and tasks	Scaffolds phrase lis g	in st Scaffolds k cloze form	Longer-term word bank by ats
Categories	Content Goals Conceptual know Meaning of equiv of fractions Procedural know Rule for expandir fractions	Vledge: valence vledge: rng	eanings eanings ne searching a finer amount is shaded occedures filed by dividing the numer or with the same number.	Lexical Meaning-re vocabulary Formal vocabulary	hated Part of a whole same amount finer structured numerator denominator to multiply by to expand
General Orientations	Rich disc instead o	course practices of isolated word Offens defen	s sive rathe sive appr	Focus on understar explaining er than toach	conceptual iding and g meaning



Fig. 4 Outcome of the case analysis: relevant categories for IDENTIFYING language demands and their interplay ( $\leftrightarrow$ ) and distinctions ( $\updownarrow$ )

### Structure of CPD: Four PD sessions of 3-4 hours each within 1 year





and lists of

Strategical scaffolding and Pedagogical tool: Scaffolding and variation

- Our approach seems too ambitious......
- Teachers do not have/get/take enough time for PD
- The topic of the PD (language sensitive math teaching) tends to broaden because it involves a lot of teacher competences (differentiating, leading good class discussions, follow up on students ideas, use advanced PCK etc.)
- The risk is we can only work on awareness or do too little of evrything

# Your questions and suggestions?

# Thank you!

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