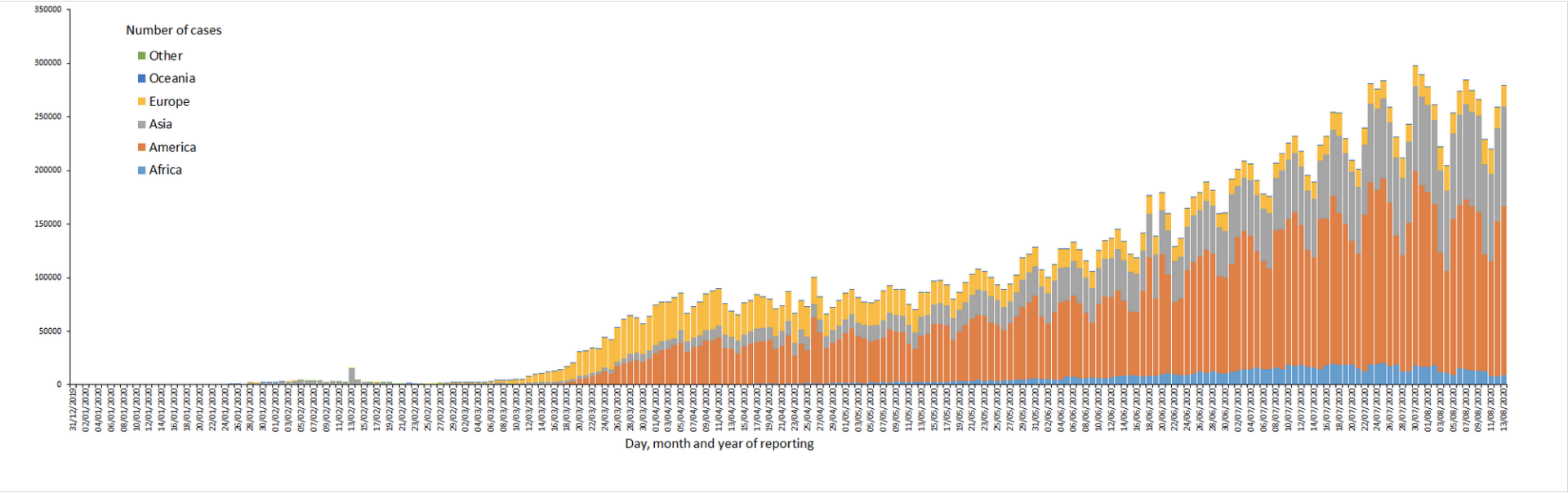
Professional development
Language of tables and graphs
Session 1 (of 3)

Utrecht University

To start with ……. From the news today

What do you notice? What is the story with this graph/graphic?



Program of the course 3 sessions

Session 1: The language of graphs and tables

some background

examples of tasks and student work in general and vocational contexts

Session 2: Focusing on line graphs

mathematical concepts

related language

Session 3: Rich communicatie practices involvog graphs and tables in vocational situations

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1. Starter
2. About the relevance of language
3. About the teaching materials
4. Activity: worksheet and student work
5. Scaffolding
6. What does this mean for your teaching practice?
7. Reflection and looking forward

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Two functions of language

- Social function: communication and learning together
- Individual function: thinking

Discussion, interaction and argumentation
are the basis for reasoning and reflection.

(Vygotskij, 1986)

Why do students need to learn language in the lessons?

They need language to *understand:*

- Written language (methods, assessments)
- Oral language (what the teacher and other pupils say)

They need language to *talk and write*

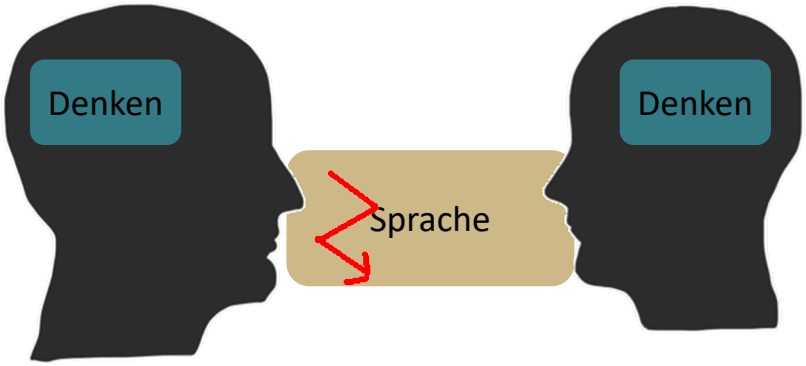
- Talk: to participate in the math classroom
- Write: to make notations (on the thinking).

(Maier & Schweiger 1999, Morek & Heller 2012)

Problems for students

Language for communicating

Someone with less language proficiency, has difficulties expressing thoughts

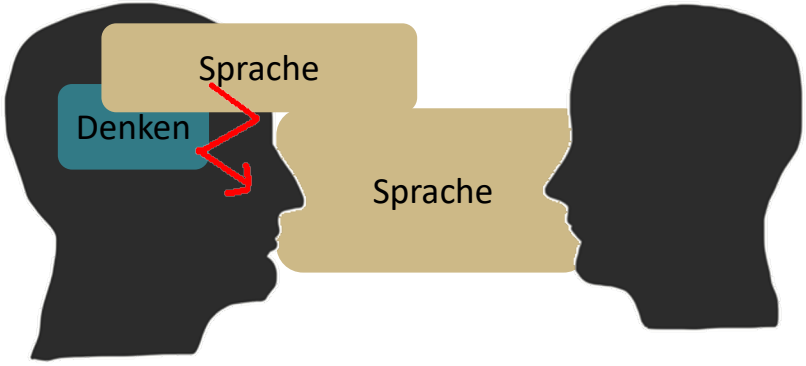


Problems

- reading of tasks
- presenting
- writing

Language for thinking/understanding

Someone with less language proficiency, has difficulties with understandig



Problems

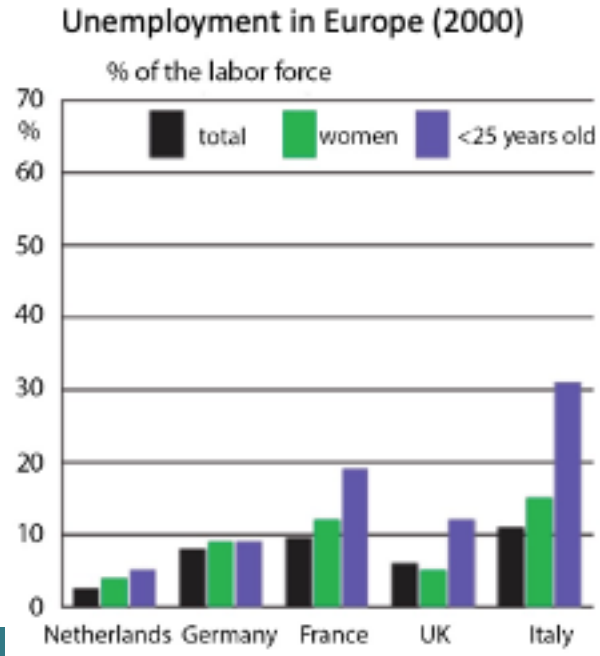
- explaining (to self or others)
- understanding connections (by thinking)
- thinking by writing

The language of mathematics

Every schoolsubject has its own language.

The language of mathematics is different from the language of other schoolsubjects.

Mathematical language has specific features



a. Which country has the lowest unemployment rate?
b. What percentage of the labor force in France is unemployed?
c. Which country has an unemployment rate of approximately 11%?
d. Which population group has the highest unemployment rate in all countries?
e. What percentage of the Italian labor force under the age of 25 is unemployed?

Multi-semiotic nature of mathematics

Language (text): What percentage of the Italian working population under 25 is unemployed?

Mathematical symbols: 11 %, 0,10, 20 etc.

Visual representations: bar graph

Overview features of mathematical language

Multi-semiotic nature: natural language, mathematical symbols, visual representations (graphs, charts, diagramms)
Specific academic vocabulary
Dense noun phrases
Expresses logical relations
Some words have another meaning in science than in other school subjects and in daily life (e.g function)

based on Schleppegrell, 2007

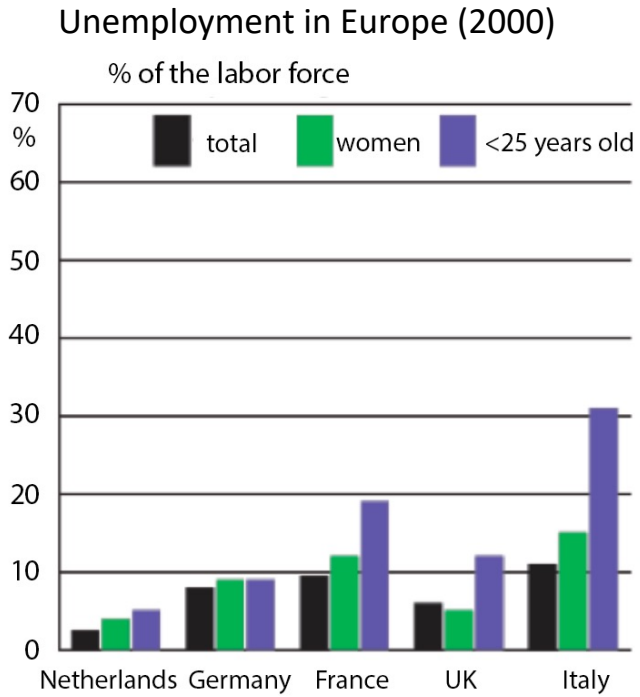
Types of language used in mathematics

General academic language (school language)
increase, relation, gradually, pattern, process

Subject specific academic language (mathematical language)
percentage, millimeter, proportion, axis, angle, cube, function

Everyday language
passengers, ingredients, parquet

Analysis of a textbook task



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c. Which country has an unemployment rate of approximately 11%?
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e. What percentage of the Italian labor force under the age of 25 is unemployed?

In small groups analyse this task:

- What types of language are used in the unemployment task?
- Look at the problem through the eyes of the students: what might be difficult for them?

Discussion of the analysis

Types of language

Mathematical language -> .....

School language -> .....

Everyday language -> .....

Student difficulties

Academic language

Academic language is the language used in school to learn, speak and write about academic subjects.

It provides acces to specialised forms of reasoning that are needed to optimally participate in particular schoolsubjects

(*Gibbons, 2009*).

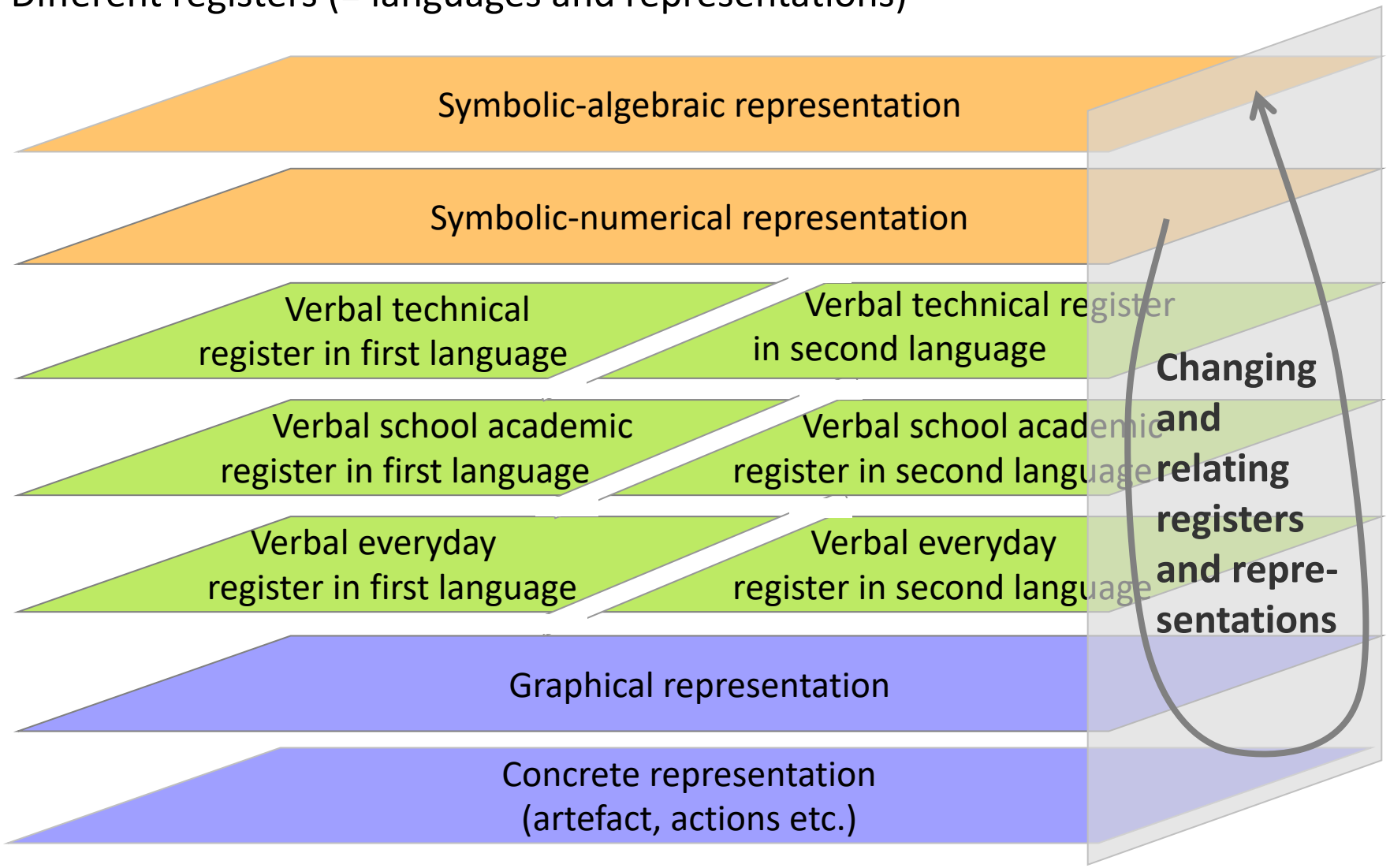
It is not only a question of learning new words but also of learning new styles of meaning and modes of argumentation.

Every school subject is constructed in language but the forms and patterns language takes vary from discipline to discipline.

(*Schleppegrell, 2010*)

What is relevant in language-responsive math classrooms?

Different registers (= languages and representations)



(Prediger & Wessel 2011, 2013; Prediger, Clarkson, & Bose 2015)

An example of students' difficulties

Numbers of students at four schools

	De Kameleon	Het Anker	De Oversteek	Sancta Maria
In 1996	338	182	220	203
In 1997	273	160	270	227

Question: At which school is the increase the biggest?

Many students answer: De Kameleon.

Can you explain this? Discuss in pairs.

An interview with Jouad on this task

T: Why do you add those numbers?

J: Because they ask at which school the increase is the biggest. You will figure out which number is the biggest

T: And you are sure this is what is asked?

J: Yes.

T: Do you understand all the words?

What does increase mean, for instance?

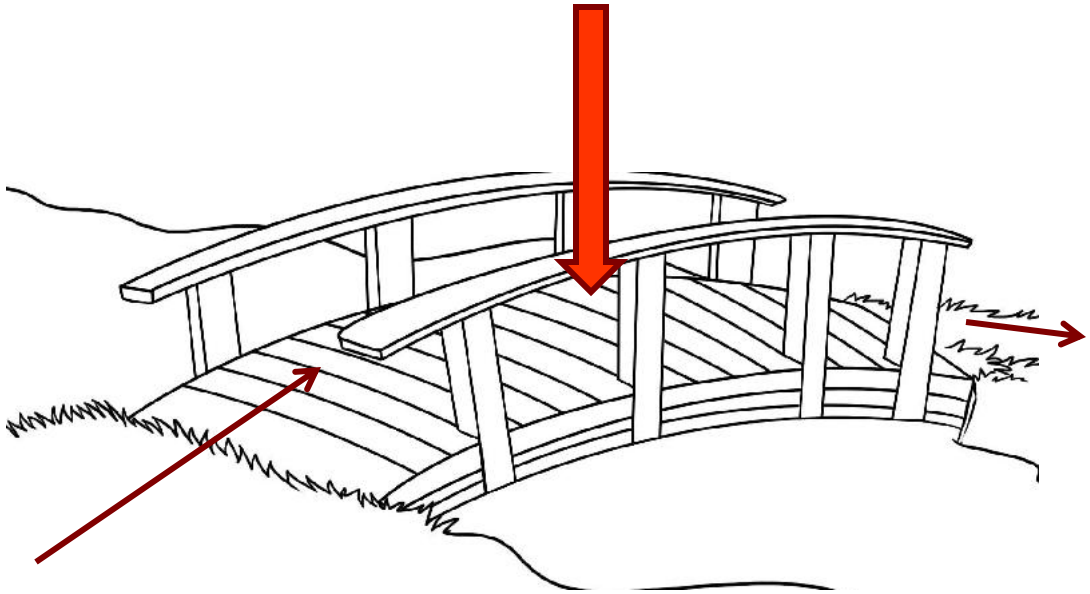
J: Eh, at which school… where is it biggest.

T: But how do you know this?

Jouad: Sometimes I just forget it.. at this question it is easy, because you already hear it 'the biggest'. So then you know, then you do not have to use increase, because you know. Then you should figure out at which school it is the biggest. So, you can leave 'increase' out of it. And then you can just calculate it.

(Van den Boer, 2003)

Bridging between BICS and CALP -> Teachers' task!



Daily language
BICS
Basic Interpersonal
Communication Skills

Academic
language (CALP)
Cognitive
Academic
Language
Proficiency

Jobs for teachers in language-responsive math classrooms

Five jobs

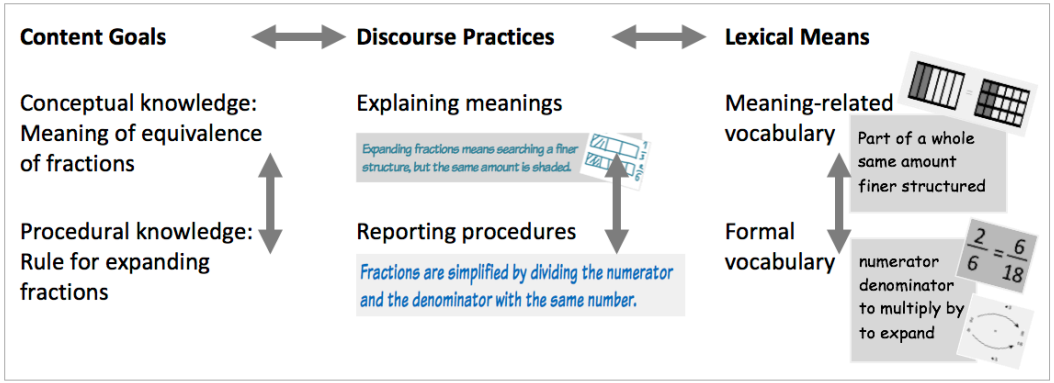
- Noticing language
- Demanding language
- Supporting language
- Developing language

Identifying mathematically relevant language demands

Pedagogical Tools

- Formative assessment tools
- Discursively activating pedagogies and tasks
- Scaffolds in phrase list
- Scaffolds by cloze formats
- Longer-term word bank

Categories



General Orientations

- Rich discourse practices instead of isolated words
- Focus on conceptual understanding and explaining meaning
- Offensive rather than defensive approach

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The language of tables and graphs

worksheets and teacher notes

Structure of the materials: 2 parts

Part 1: core communicative tasks

- Three examples of rich communicative practices related to vocational situations involving tables or graphs
- Communicative practices: giving advise, making decisions, consulting, explaining

Part 2: three lessons

- 'Traditionally structured' teaching unit for three lessons on the language of functions and graphs

Some design principles

Contexts

- 'familiar' enough to talk about
- connected to vocational situations (especially communicative tasks)
- connected to meaningful math

Interaction

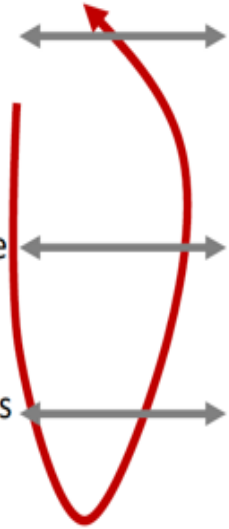
- between students – cooperative learning
- between teacher and students -> scaffolding language (and understanding)
- role-playing in vocational communicative tasks

Supporting language and improving mathematical understanding

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

Conceptual and language learning

Conceptual learning trajectory	Related language learning
Level 1a: Informal thinking and informal strategies	**Level 1a:** Collect and identify individual (everyday and school mathematical) resources for articulating informal thinking
Level 1b: Re-develop and deepen conceptual understanding in accessible (everyday and vocational) contexts	**Level 1b:** Develop shared meaning-related vocabulary for explaining meanings
Level 1c: Re-develop formal procedures (over a variety of diverse contexts or context-free, less familiar contexts)	**Level 1c:** Explicit use and training of formal and meaning-related vocabulary for reporting procedures and explaining meanings



Applications in contexts	Related language learning
Level 2 a, b, c: Applying mathematical concepts, procedures and strategies to successively more complex vocational contexts	**Level 2a,b,c:** Connecting new vocation-specific reading vocabulary to prior knowledge for enacting typical vocational discourse practices (consulting, efficiently informing, ...)

Part 1: Three communicative core tasks

- **General structure of the tasks**
  - Exploring the context and its language
  - Eploring the mathematical concepts and the mathematical language
  - Preparing the communication (e.g. writing a script)
  - Communicative practice (role-play, podcast, blog/vlog, ...)
  - Reflecting

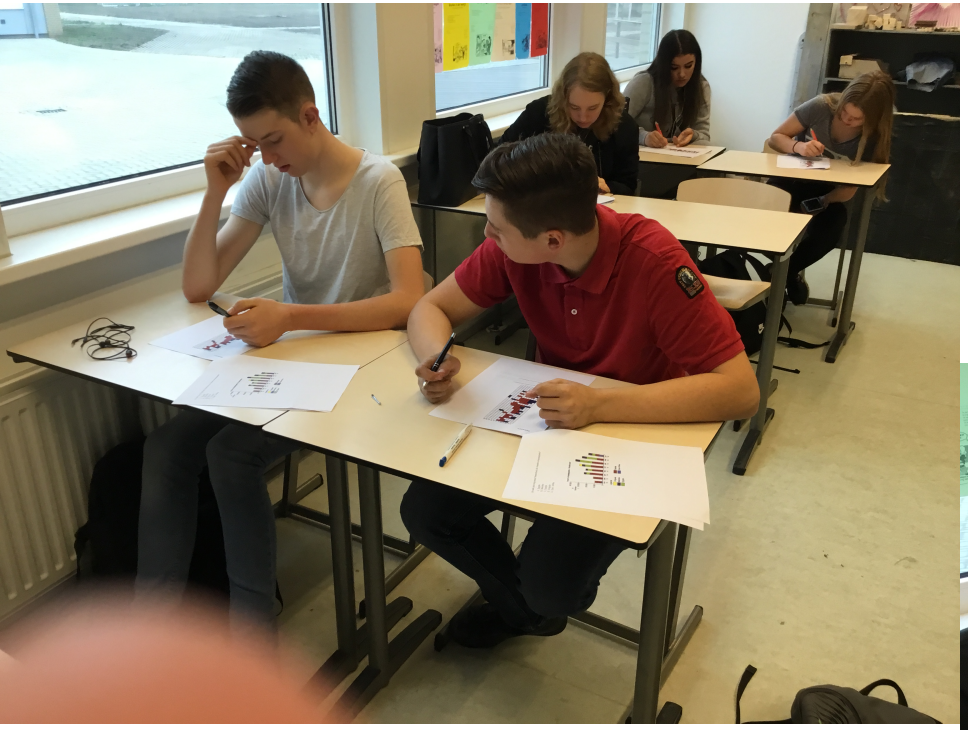
- **Note: these tasks will be the focus of PD session 3**

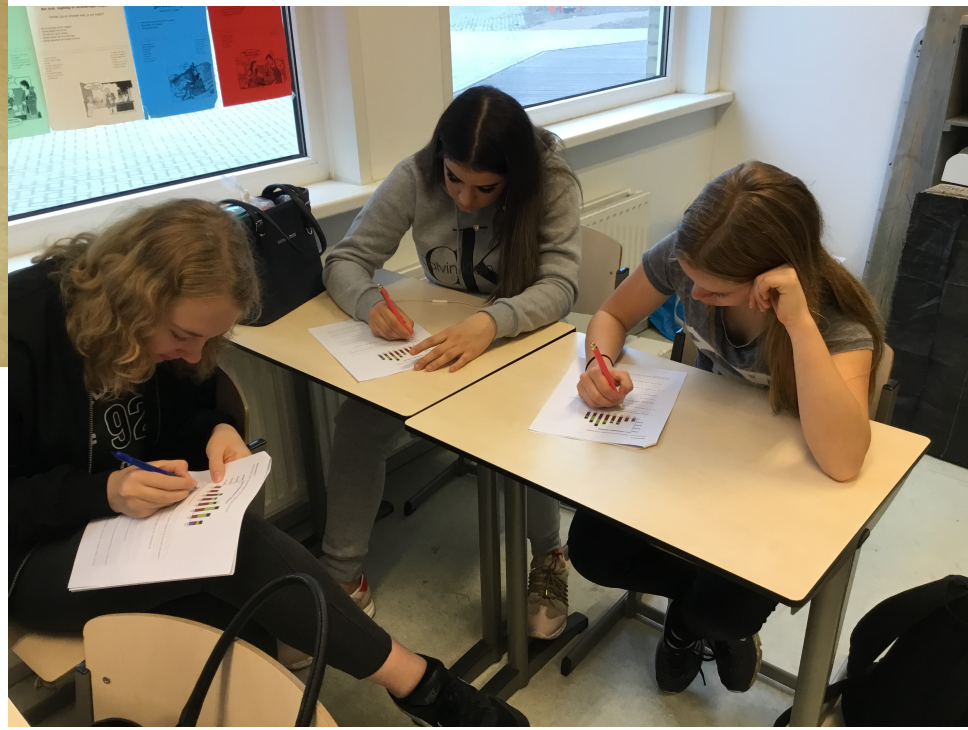
Part 2: Four ‘phases’

	Learning strand Graphs/diagrams/tables	Learning strand Language
1	Activate and re-use previous knowledge about tables and graphs, by using examples of everyday and vocational contexts	Emphasis on oral interaction, by using different kinds of language: everyday language, vocational language and academic (school and mathematical) language. Students mainly talk together and write a little.
2	Combining different representations: graphs/diagrams, tables and text especially for line-graphs. Know, name and use mathematical characteristics of each representation.	(Re-)introduce the (mathematical) language of (line)graphs/diagrams/tables. Make an explicit connection between the mathematical concepts, the mathematical language and the 'situational' language of the vocational or everyday contexts.
3	Practice the use of different representations and their connections. Broaden the number and type of representations. If needed include a stronger relation with functions.	Apply the language of mathematics for different representations (fitting situations from home, school and work) and connect this to the (complex) language of vocational situations and everyday situations

Take a look at page 9 of the unit for an overview of the types of activities

Dutch students working on the unit





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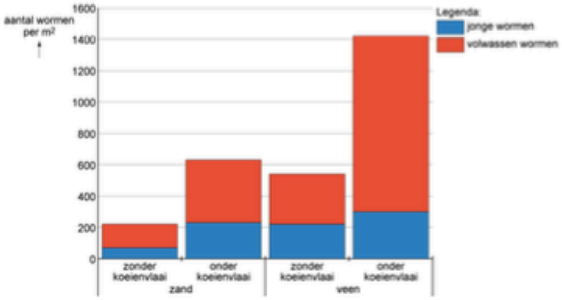
Exemplary worksheet from the unit - phase 1 (see handout)

- With a partner do the tasks on this worksheet

- Reflect on the language needed

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.

Sharing findings in the whole group

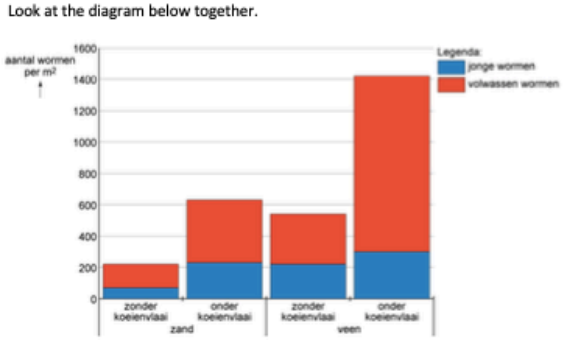
- What types of language use?
- Expected difficulties for students

Student work on worksheet 9

Students' answers on the question: what is this diagram about?

- Individually: order the students' answers from best to worst in the table at the bottom of the worksheet.
- In pairs: share your orderings and your reasons behind it and together make a list of language related difficulties the student work shows.
- Whole group: collect student difficulties in a list. Come up with means to support the students in overcoming these difficulties

Look at the diagram below together.



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Scaffolding language

Adaptive linguistic support that helps students in developing the language abilities that enables students to think and communicate independently in school subjects.

(*see Gibbons, 2002, 2009*)

What is scaffolding?

- Scaffolding refers to a variety of *instructional techniques* like asking questions, reformulating, structuring in steps.

- Scaffolding is not just any help or support. It is *temporary and responsive* support to help students to reach higher levels of comprehension or development of skills than they would not be able to achieve without assistance.

- Scaffolding ultimately aims at students' *independence* in the learning process.

(*Wood, Bruner & Ross,1976*).

Repertoire of scaffolding strategies

- Reformulating or extending pupils' spoken or written utterances
- Referring to or reminding of linguistic features
- Referring to or reminding of structure features
- Asking pupils to improve language
- Repeating correct pupils' utterances or making explicit the good quality of pupils' utterances
- Asking for or encouraging pupils' explicitly to independently produce spoken or written language

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Answer the questions in the poll

- In your teaching practice to what extent do your students face language related problems? Give one or more examples.

- In your teaching practice do you pay specific attention to 'the language of mathematics'? Give one or more examples of how you do this.

- What means do you use to support students language development in your teaching? Give one or more examples

Prepare a language-sensitive activity on graphs/diagrams

in small groups discuss these steps and think of an example to use in class

Select an approriate graph/diagram

What is the mathematical content and goal for the activity with this graph/table/diagram? What task(s) do you give students?

What are the linguistic demands in this activity and what goal(s) do you set related to the use of (mathematical) language?

How do you plan to activate your students in producing language in this activity?

What language support do you provide?

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Reflecting on the session

What was an eye opener for you?

What do you take home (to school)?

Write a tip and a top.

For the next session

1. Prepare and design a language-senstitive teaching activity with a diagram/graph

Use the lessonplan (in the handout)

Include all student materials

2. Try this activity with your students (whole claas or small group)

Write a brief report: what went well? What problems arose? What improvements would you make to overcome these? Include some examples of the work of your students.

Bring all materials with tou to session 2.

In this session we will share materials and findigs and we will focus on the topic of line graphs.