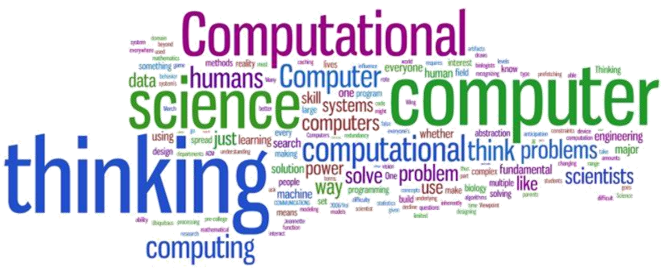

Computational Thinking for Everyone?

Modeling for Everyone!

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Why?

- Austrian Curricula
  - Secondary school curriculum
    - “Basic Digital Education” incl. **computational thinking** [1]
  - Primary school curriculum
    - Capacity of **abstraction** by using **diagrams** or **symbols**
    - Basic cognitive processes like comparing, **sorting, classification, abstraction, generalization** etc. [2].
  - CT and modeling involve these thinking processes!
- International Research
  - Informatics didactics - Approach „Models first“ in CS education
    - Modeling determines way of thinking in problem solving
    - **Modeling** = **„mother tongue of problem solving**“ [3]
  - Neurodidactics
    - Modeling effective learning strategy (concept maps [4])
- Personal Teaching Experiences
  - Computer science
  - Foreign languages

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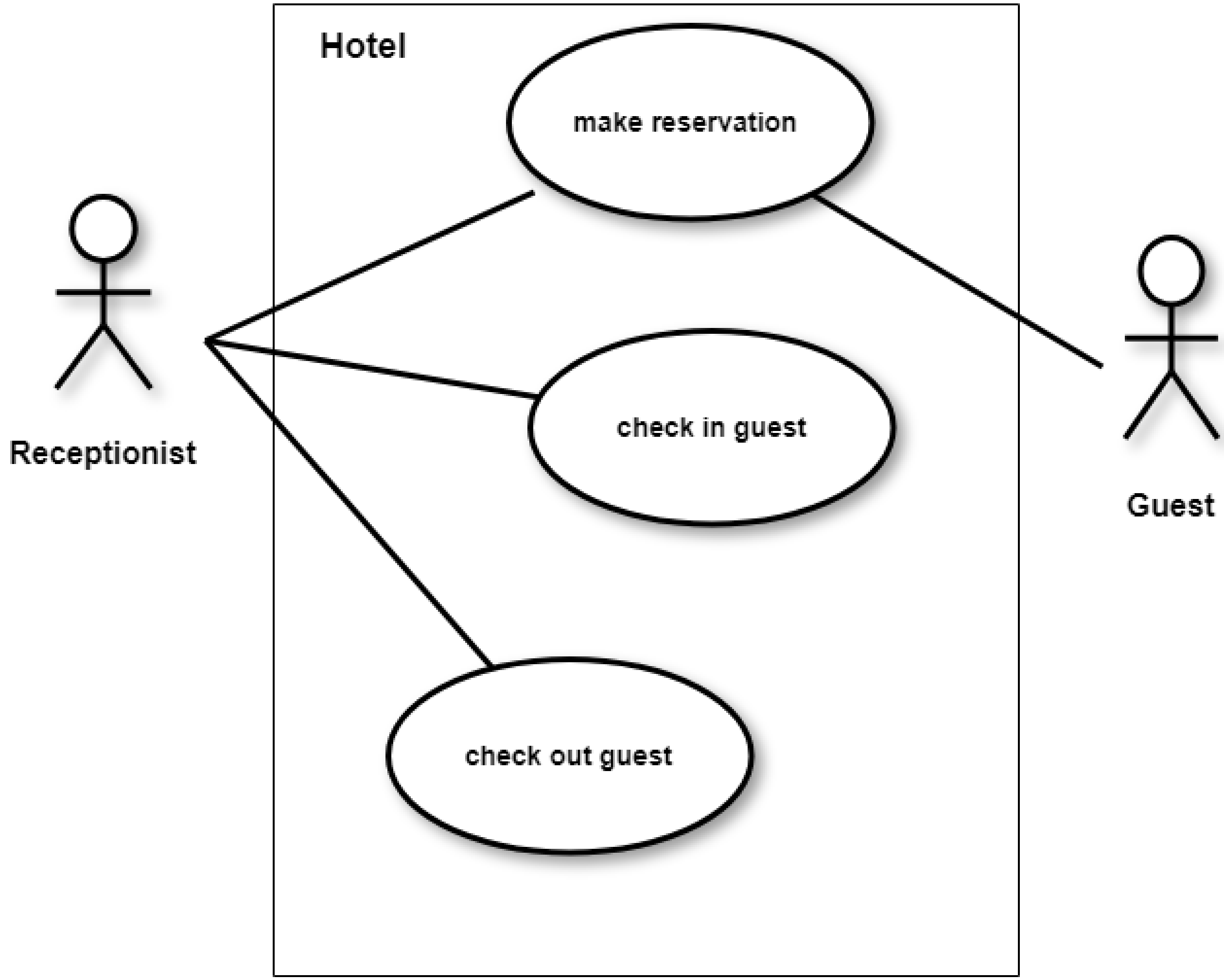
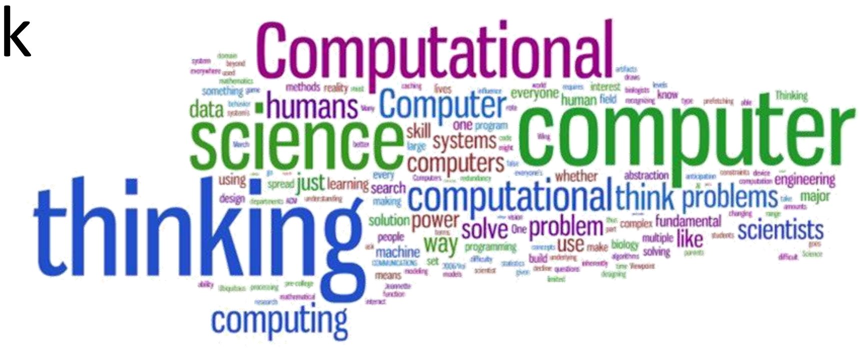
Text Comprehension & Production



Overview

- What?
  - CT = Problem solving methodology
  - Modeling = Brain-supporting learning strategy
- How?
  - CT & Modeling in practice
  - Sample projects & Activities
  - Experiences & Results
- Conclusion & Outlook



What?

- Computational Thinking =
  - „Problem solving process“ [5]
  - „[..] the use of **computer science concepts** to **solve** a **problem** in **any domain“** [6]
  - “[...] the goal of computational thinking is to solve problems” [7]
- Modeling =
  - Building models, **abstract description** of a real or planned system [8],
  - **reduced** and **simplified representation** of real world, containing only **essential information** or elements

Computational Thinking

Problem Solving

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CT = Problem-Solving Process

That includes (but is not limited to)

- **Formulating problems** in a way that enables us to use a computer and other tools to help solve them
- **Logically organizing** and **analyzing** data
- **Representing** data through **abstractions** such as **models** and **simulations**
- Automating solutions through **algorithmic thinking** (a **series of ordered steps**)
- **Identifying, analyzing,** and **implementing** possible **solutions** with the goal of achieving the most efficient and effective combination of steps and resources
- **Generalizing** and **transferring** this problem-solving process to a wide variety of problems [5]

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4 Stages of CT

- **Decomposition**
  break down a problem into subproblems
- **Pattern recognition**
  notice similarities, differences, properties, or trends in data
- **Pattern generalization**
  extract unnecessary details and generalize those that are necessary in order to define a concept or idea in general terms
- **Algorithm design**
  build a repeatable, step-by-step process to solve a particular problem [9]

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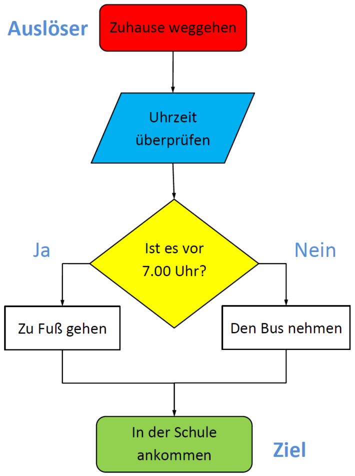


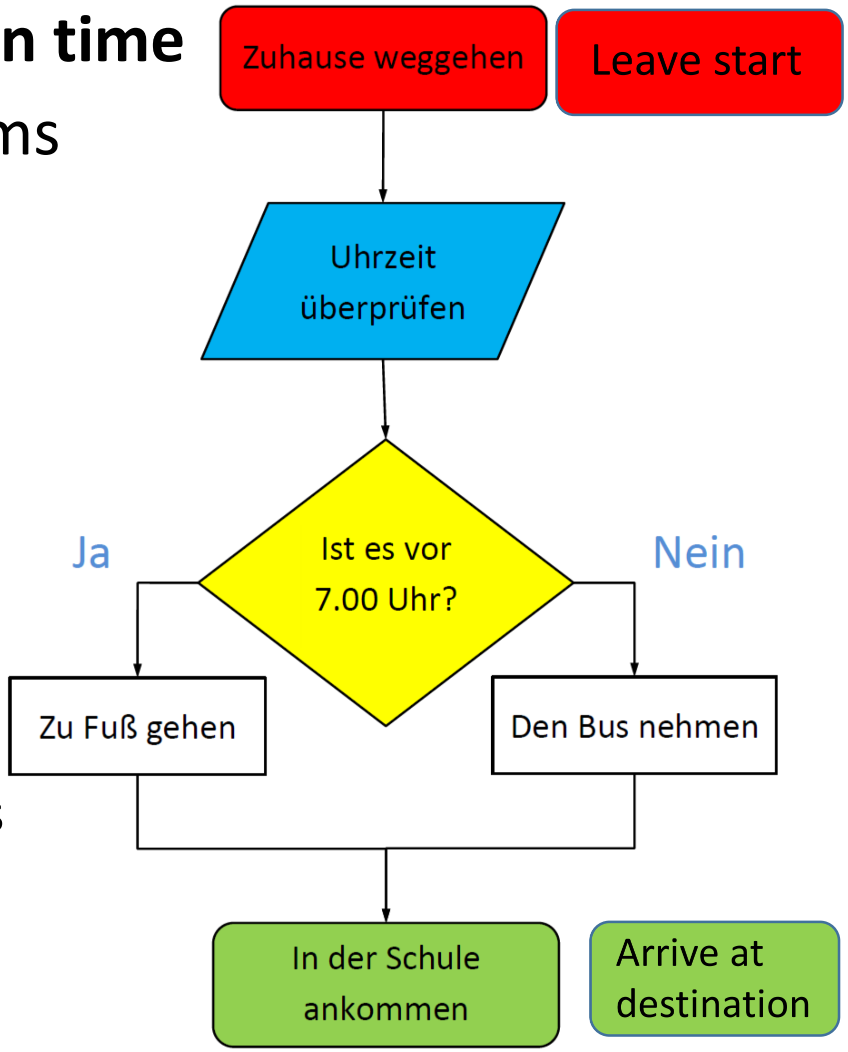
Modeling at School

1. Fostering Computational Thinking
2. Brain-based Learning Strategy for different Subjects

Computational Thinking

Problem: Arriving at school in time

- Decomposition: subproblems
  - Leave
  - Check time
  - Decide
  - Go (by foot or bus)
  - Arrive
- Pattern recognition
  - Always the same
- Pattern generalization
  - Essential + general elements
- Algorithm design
  - Step-by-step solution



Modeling supports

- Problem solving
  - Analyzing problems
  - Breaking down in smaller problems
  - Finding solutions for small problems
  - Combining parts to complete solution
- Text comprehension & production
  - Recognizing and extracting essential information
  - Summarizing texts
  - Understanding the “big picture” and relationships
  - Creative writing and storytelling
- Knowledge acquisition & representation
  - Structuring
  - Categorizing
  - Abstraction
  - Generalization
  - Visualization
- Etc.

Modeling = Learning Strategy

- Modeling **in general**
  - Concept maps and other **visualization** techniques

  -> Supports the learning process in the human brain [10]
  - Benefit of **priming effect** – implicit memory effect:
    an appropriate unconscious stimulus influences (positively) the memorizing of the following input
  - **Advanced organizers** (brain needs structure!)

  -> Especially effective for children with learning difficulties [4]

- Modeling with **diagrams** from **computer science**
  - Same benefits – more possibilities
    - Numerous diagram types
    - More different learning purposes and situations
  - Teaching **computational thinking & digital literacy**

  -> demanded in curriculum & as 21st century skills

HOW?

CT & MODELING IN PRACTICE

Connecting CT to Everyday Life
Example: Activities of Primary School

- Organizing, searching, sorting pictures & objects

  ⇨ **Searching & Sorting**

- Traffic signs & secret languages

  ⇨ **Encoding & Encryption**

- Finding generic terms & similarities

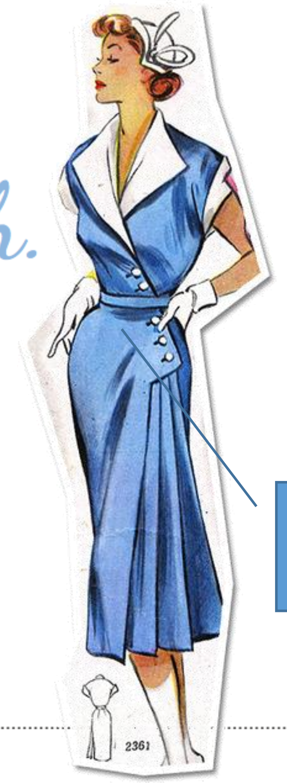
  ⇨ **Abstraction & Generalization**

- Describing the way & step-by-step instructions

  ⇨ **Algorithms & Modeling**

[11]

Kleid mit schrägem Schluss.
Dress with diagonal finish.



Erforderlich: etwa 3,50 m Stoff, 90 cm breit;
0,80 m Stoff, 90 cm breit für Garnitur

You'll need about 3,50 m fabric (90 cm wide);
0,80 m fabric (90 cm wide) for trimming

Programming: Declaration of variables

Encoding

Modeling

Farbe/Colour	**Nr.**	***Bezeichnung***	
	230	*Vorderteil*	Front part
	231	*Rückenteil*	Back part
	232	*Garnitur, 4mal zuschneiden*	Trimming, cut 4 times!!
	233	*Ärmelaufschlag*	sleeve cuffs
	234	*Linke vord. Rockbahn*	left front skirt panel
	235	*Faltenteil zum Rock*	pleat's piece
	236	*Rechte vordere Rockbahn*	right front skirt panel
	237	*Innenbekleidung zum Rock*	Inner lining of the skirt
	238	*Rückwärtige Rockbahn*	Back skirt panel
no line	239	*Gürtel, 95 cm lang, 3 cm breit*	Belt, 95 cm long, 3 cm wide

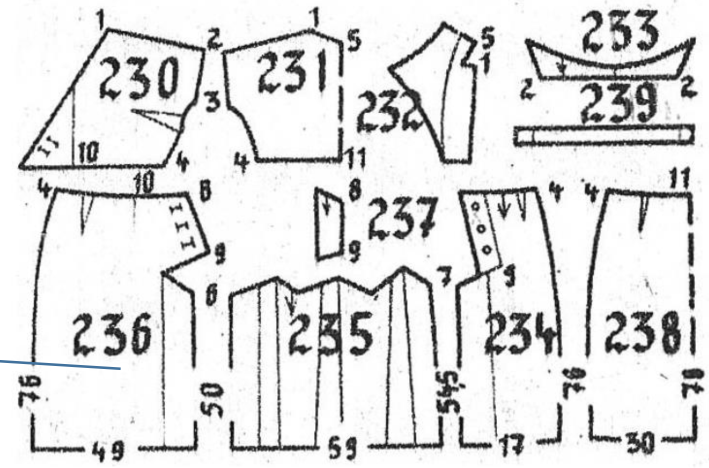
http://neu4bauer.blogspot.co.at/2011/04/freebie-vintage-pattern-from-our-april.html, adapted

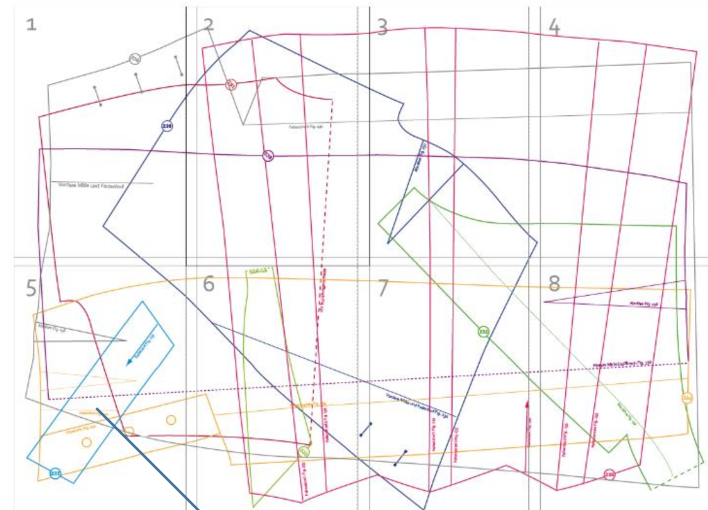
Abnäher, Seiten- und Schulternähte schließen. Rechten Vorderteil bei den Knopflöchern verstürzen. Ärmel in den gedoppelten Stoff des Aufschlages fassen. K… in den für sich versäube… …en. Die beiden vorderen R… …den Faltenteil verbinden. R… …bei den Knopflöchern, linke Bahn am Knopfrand verstürzen. Falten einheften und die rechte Rockbahn schmalkantig aufsteppen. Abnäher und Seitennähte schließen. Rock an die Taille nähen. Der linke Vorderteil wird nur bis zum Knopfrand der linken Vorderbahn angenäht. Der lose hängende Teil wird innen mit einem Druckknopf befestigt. Gürtel doppeln, mit Knopfschluss versehe…

Algorithms Sequencing

Algorithms

Close darts, side and … over the right front part at the buttonholes. Sew the sleeves into doubled fabric of the cuffs. Double the collar and sew into the serged neckline. Turn over both the front skirt pieces at the buttonholes as well as the left skirt piece. Crimp all the pleats into place and place the right skirt piece on the pleat's piece allowing only a very narrow lap.
Close darts and side seams. Sew the skirt onto waistline. The left front part is only sewn til the button ridge of the left front panel. The loose part is fastened with a press-stud in the inner part of the dress. Double belt and close the belt with a press-stud too.



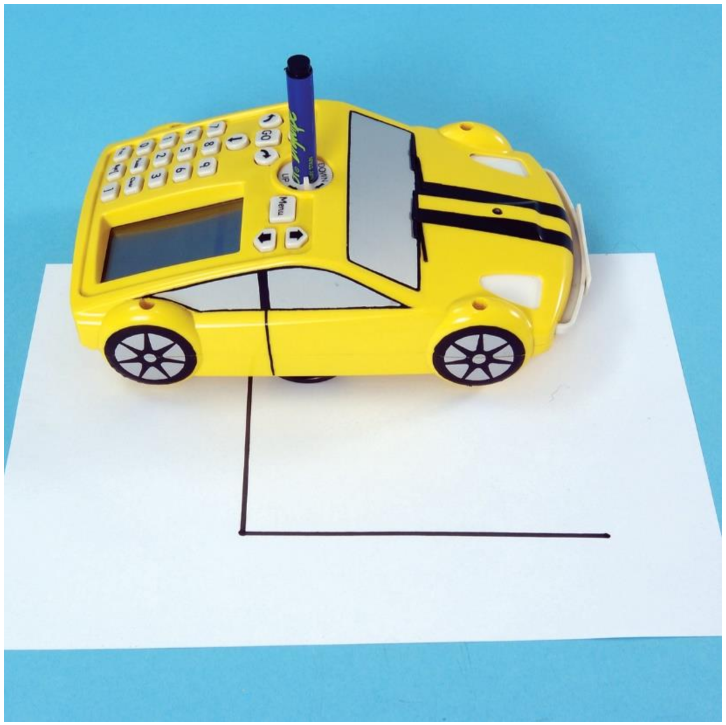


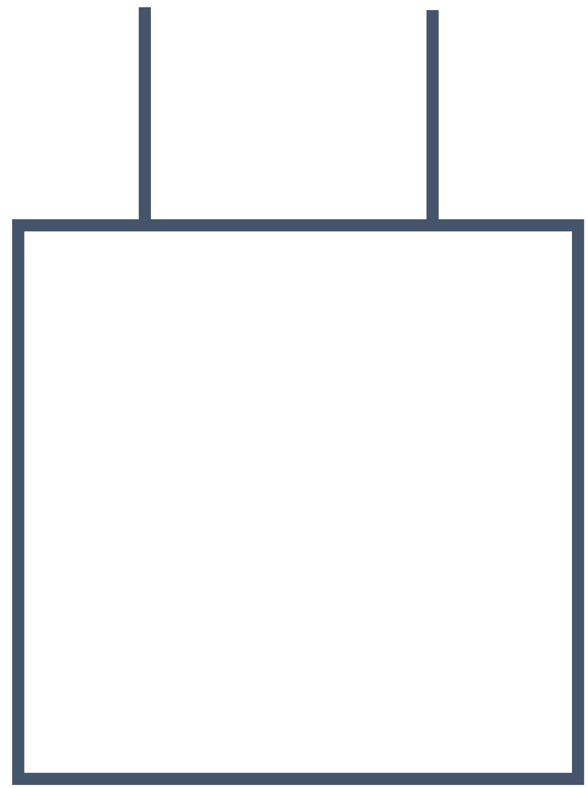
Sewing patterns

Modeling Encoding

A pattern by neu4bauer.blogspot.com

Designing & Modeling a Shirt





Research Focus: Modeling

1. **How** and **where** can we **introduce modeling** in primary and secondary education?
2. Which **modeling techniques are useful** and practicable for teachers and students **without informatics background**?
3. Which dimensions and aspects of the modeling process are or shall be **part of general education**?
4. Is it possible to **improve general learning competencies** like abstraction, problem solving, text comprehension etc. by a frequent and varied use of modeling in primary and secondary education?

Modeling across the Subjects – Projects Overview

Project	Students (School)
Informatics Summer Lab (2014)	77 (6 - 17 years)
Informatics - A Child's Play?! (Sparkling Science, 2014-2018)	150 (primary, secondary)
Modeling in English language teaching (Diploma thesis, 2015)	141 (lower secondary)
Game design in English as foreign language (Case study, 2016)	19 (higher secondary)
Modeling at school (EU project application, pilot phase, 2018)	57 (secondary)
Participants (total)	**444**

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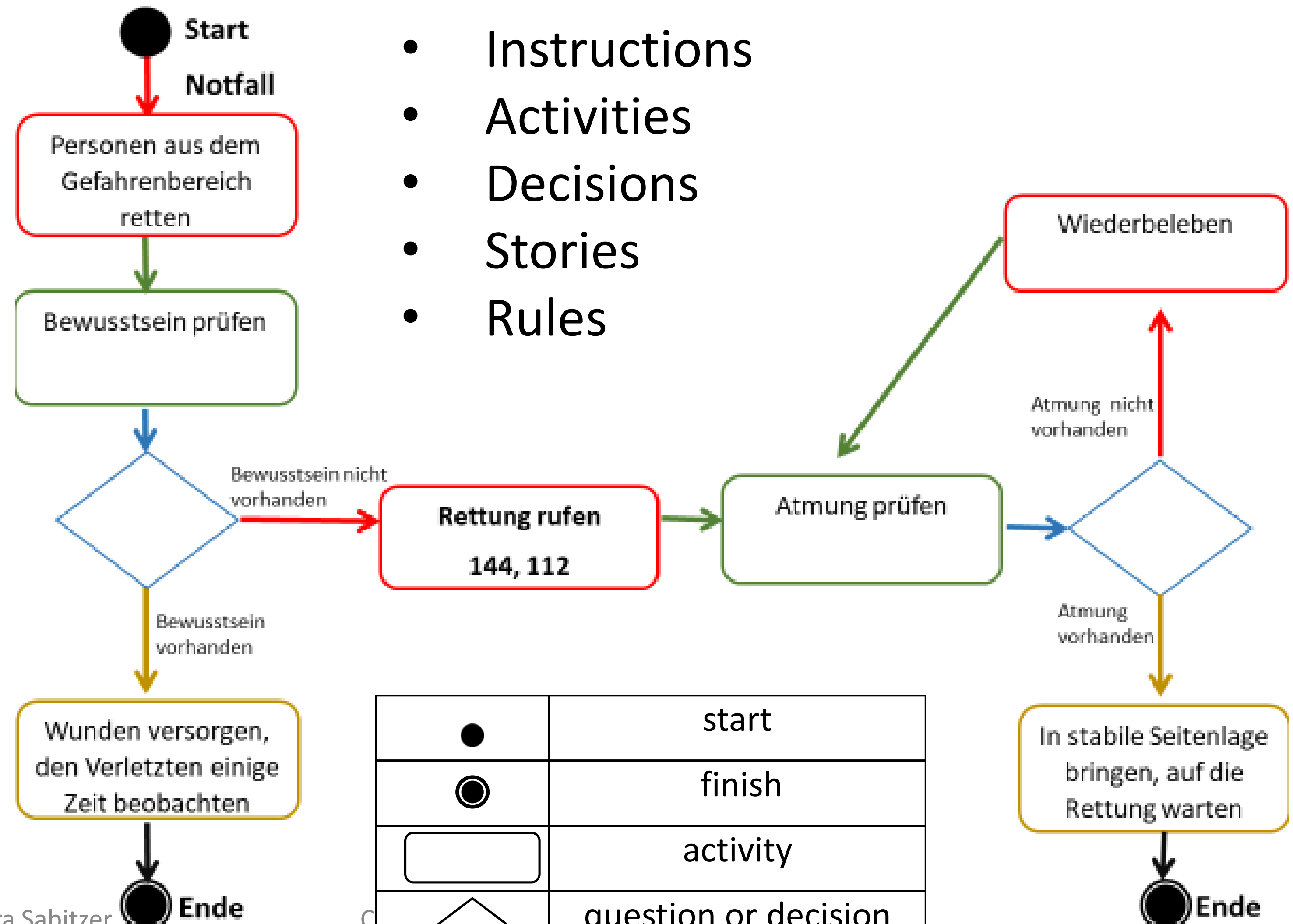
Which Models in Which Context?

Activity Diagrams

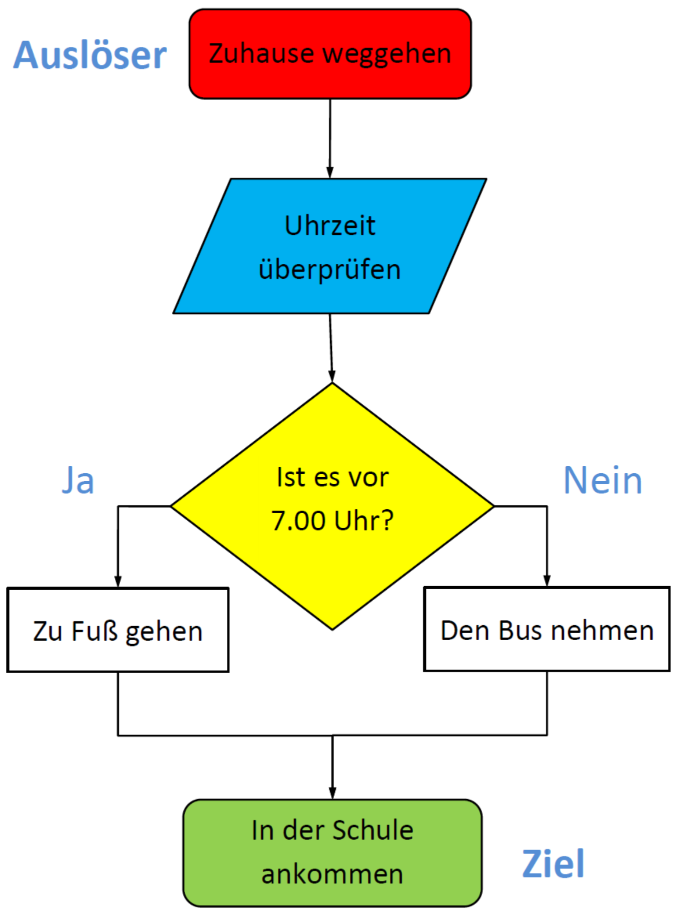
- Instructions
- Activities
- Decisions
- Stories
- Rules



●	start
◉	finish
▭	activity
◇	question or decision

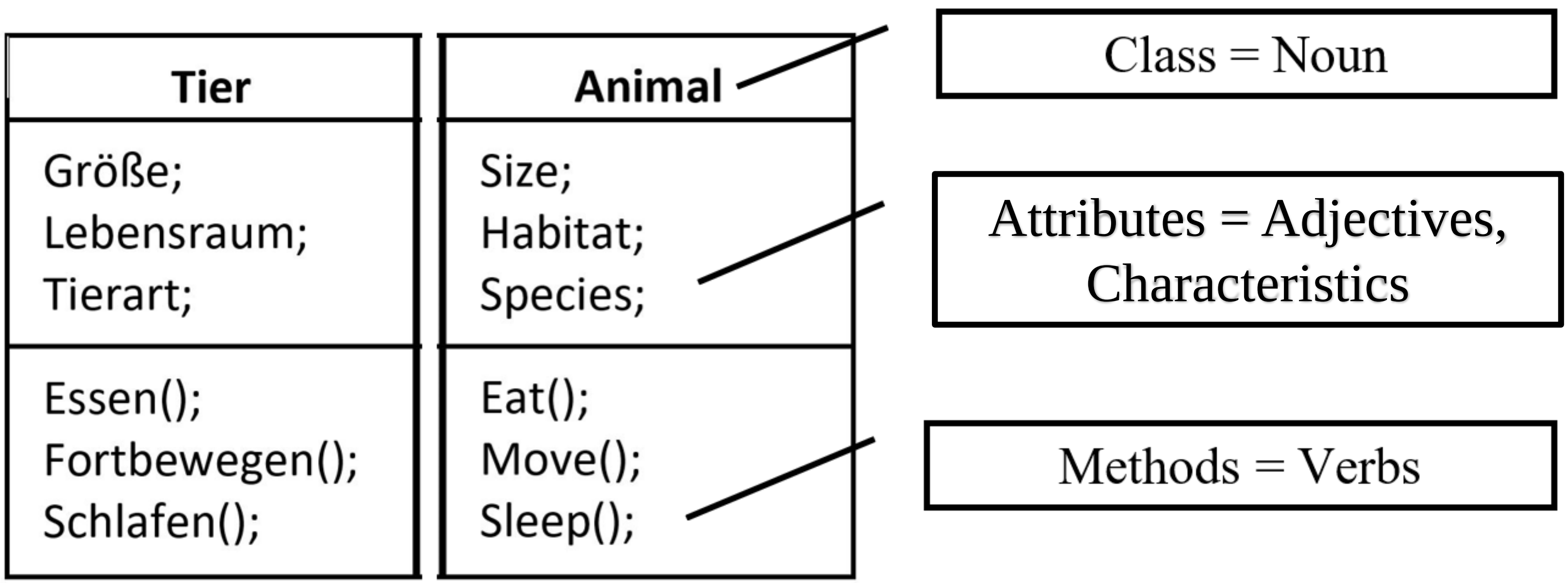
Modeling Processes: Flow Chart

- Leave home
- Check time
- Is it before 7 am?
    - Yes: walk
    - No: take the bus
- Arrive at school
- Useful for
    - Processces
    - Rules
    - Instructions



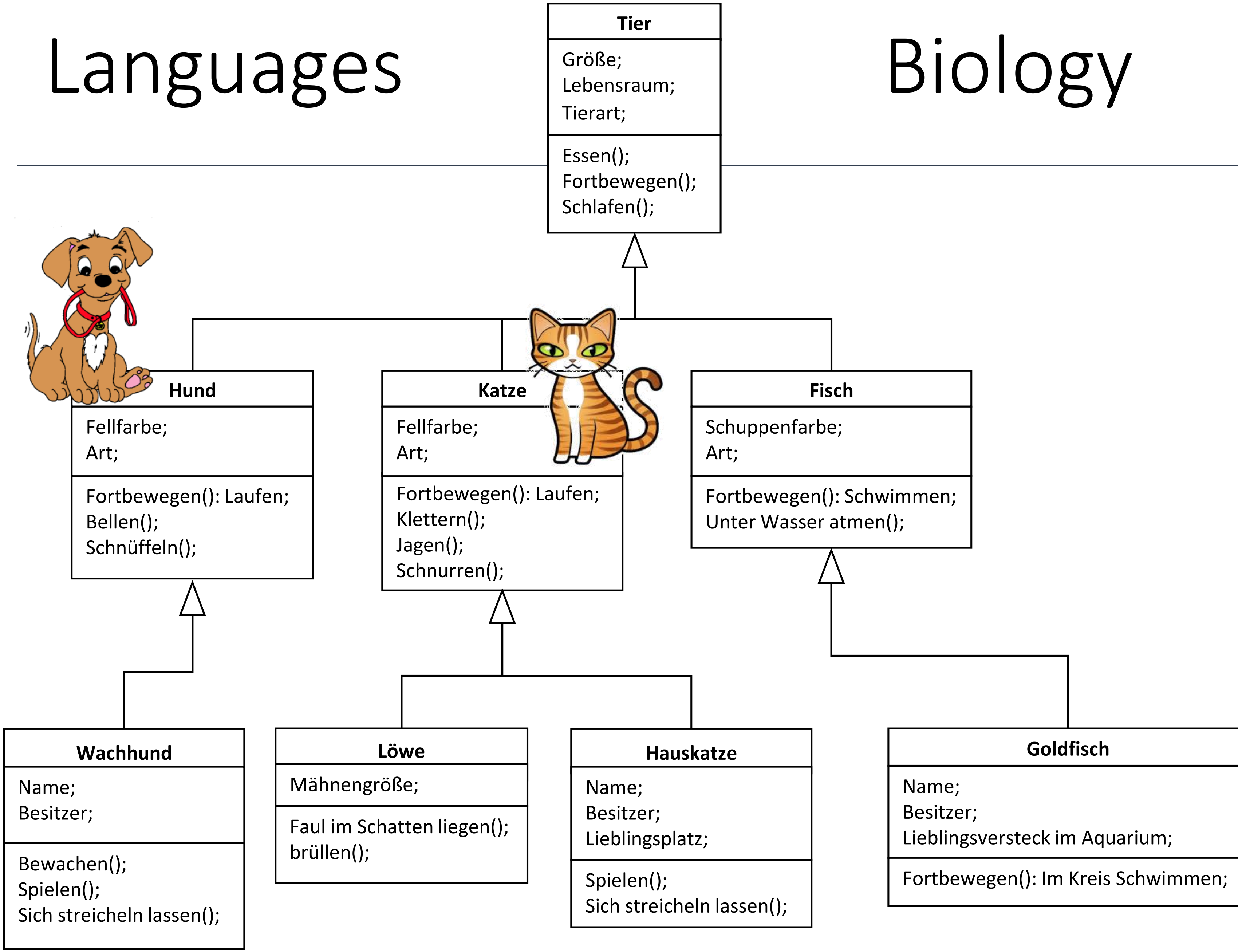
Class & Object Diagrams

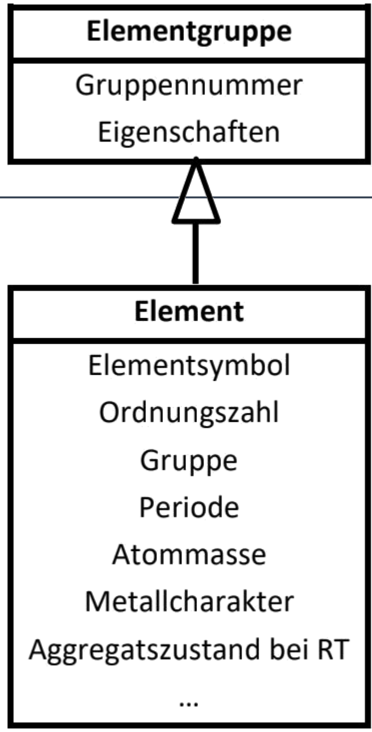
- Vocabulary
- Characteristics
- Word classes
- Categories
- Hierarchies
- Abstractions



Languages

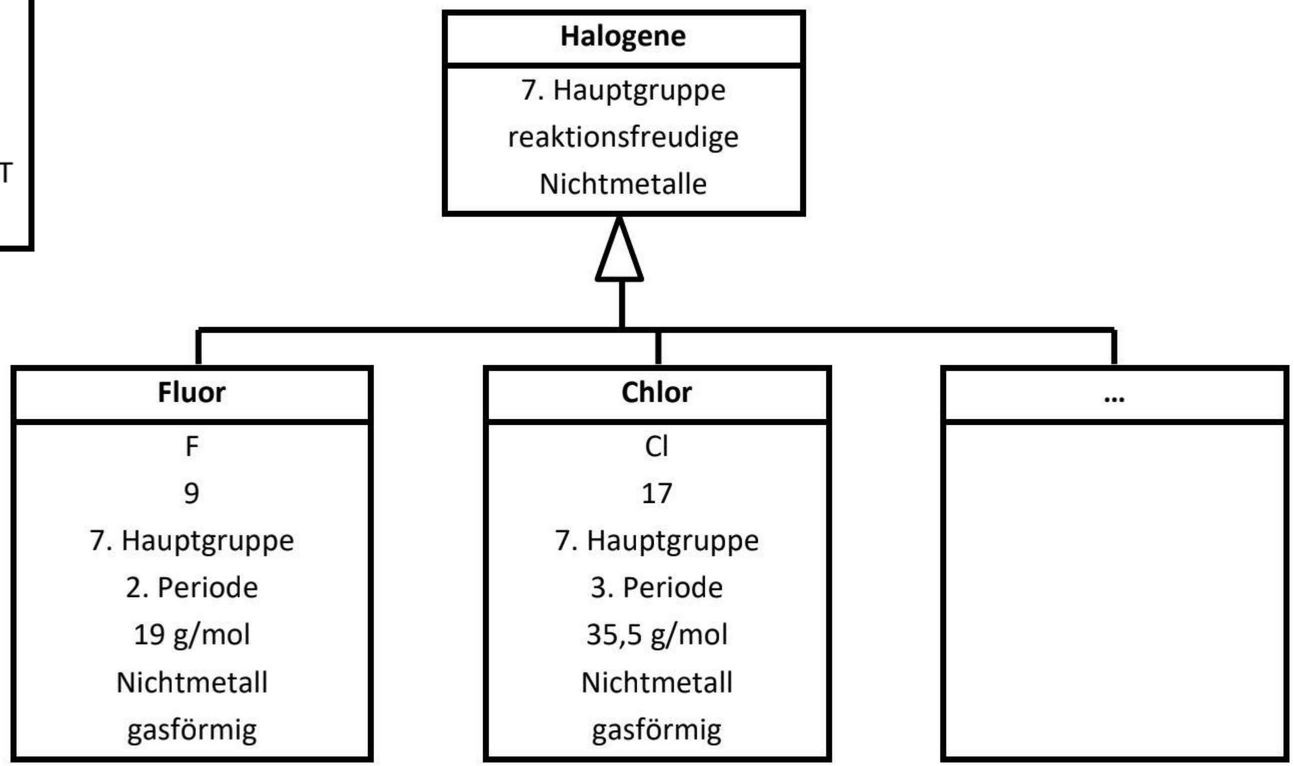
Biology





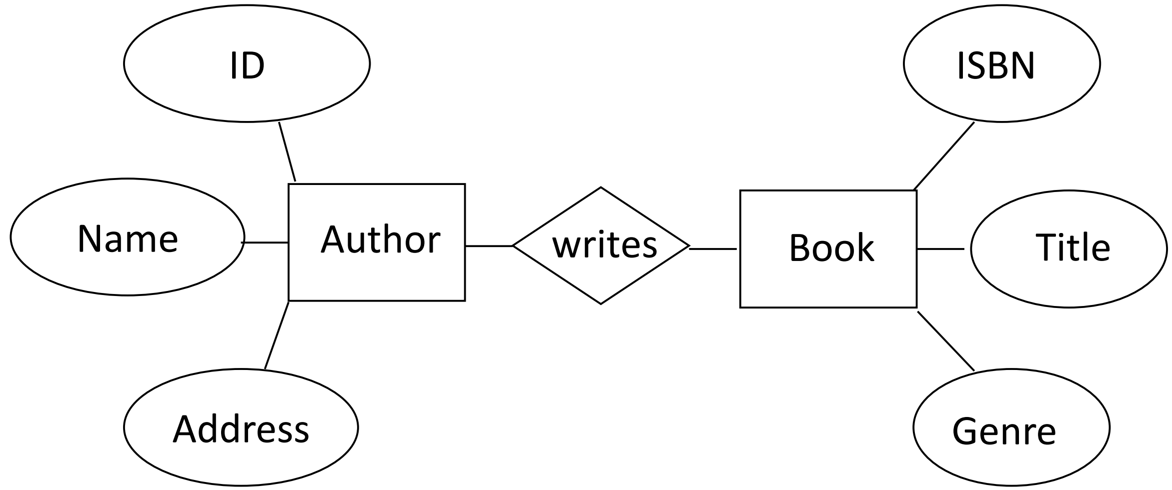
Chemistry

- Class & Object diagrams
- Classifying elements



Entity Relationship-Diagram

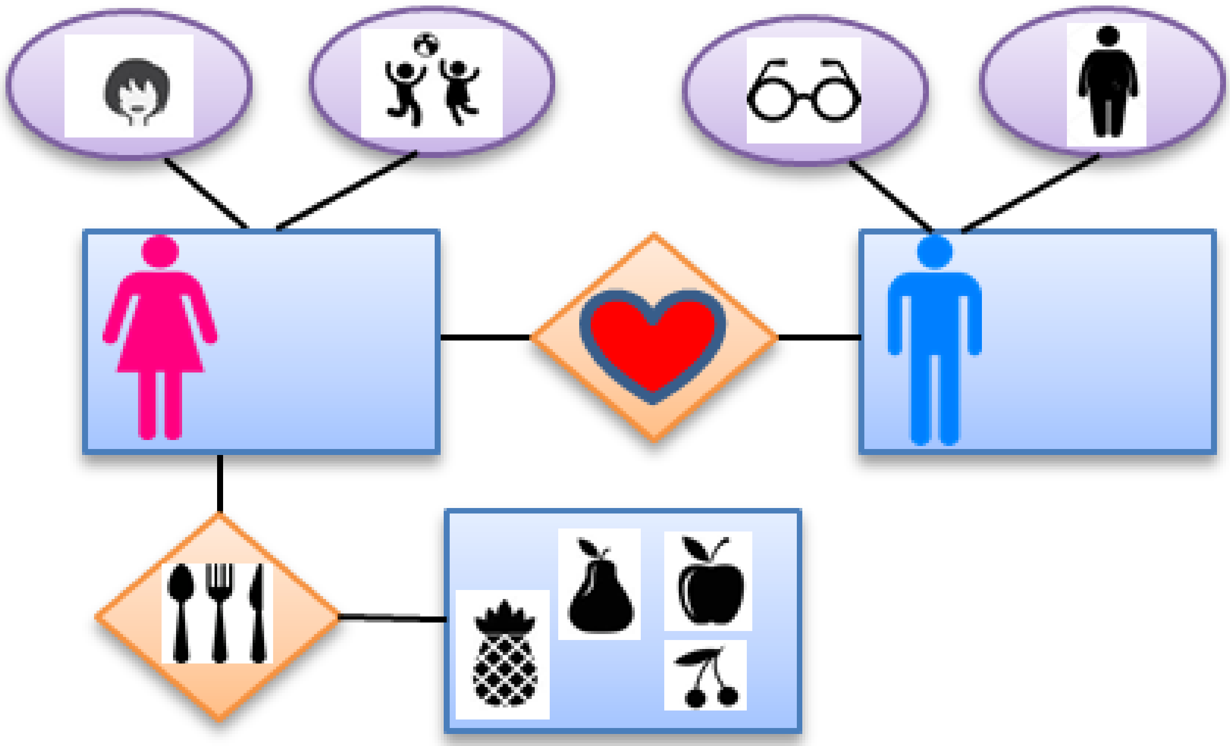
- Brainstorming
- Writing
- Summarizing
- Relations
- Vocabulary
- …



Form and color	**Computational expression / meaning / function**	**Used in the English foreign language as…**
Rectangle: **blue**	Entity	Nouns
Rhombus: **green**	Relationship	Verbs
Ellipsis: **yellow**	Attributes	Attributes, such as adjectives, adverbs, and so on.

Notation of ER-diagrams in English as foreign language [13]

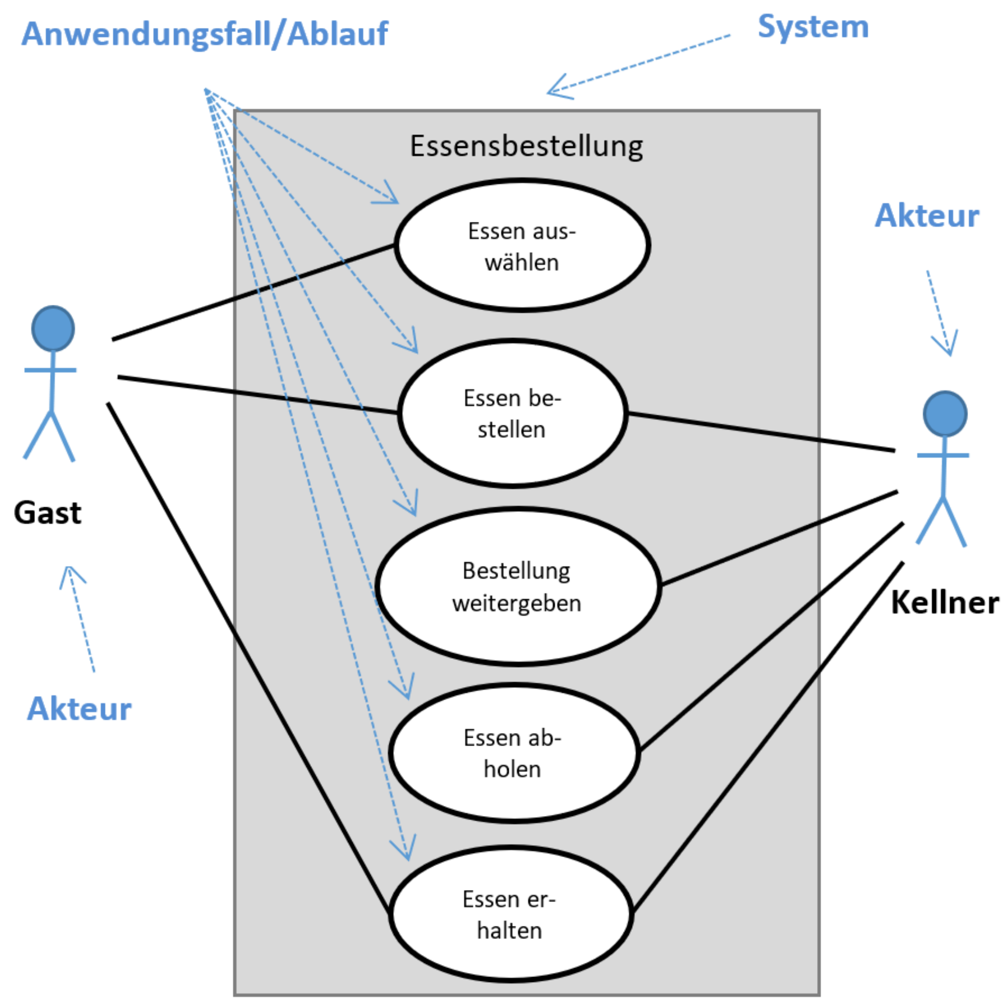
Tell a story!



Sample ER-diagram "Tell a story!" used in a unit for kindergarten [14]

Use case diagrams

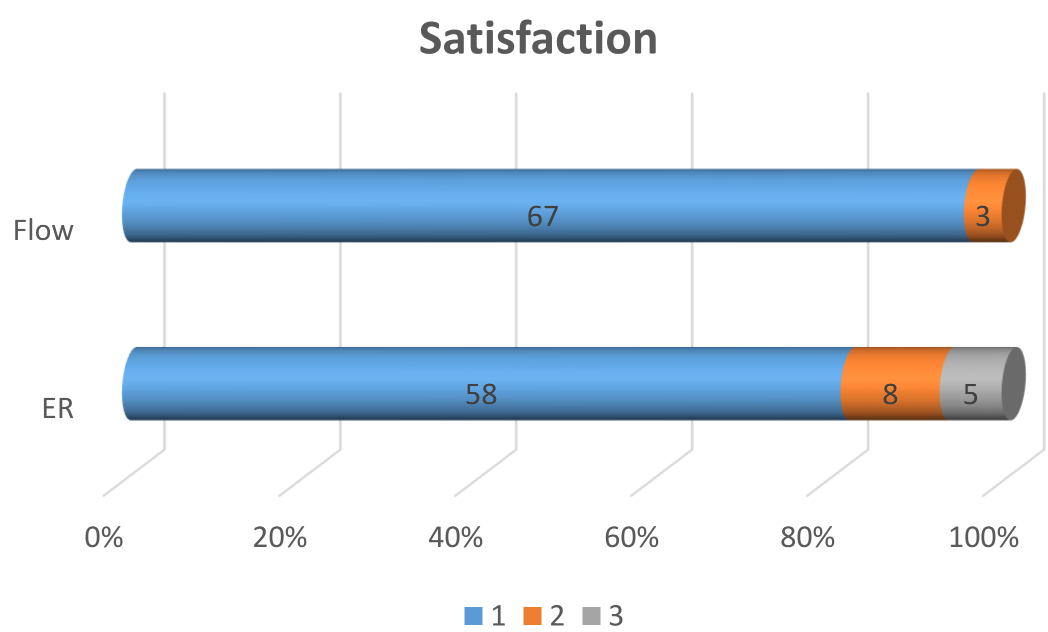
- Situations
- Events
- Actors
- Activities
- Theater
- Film plot
- …



Results: Acceptance

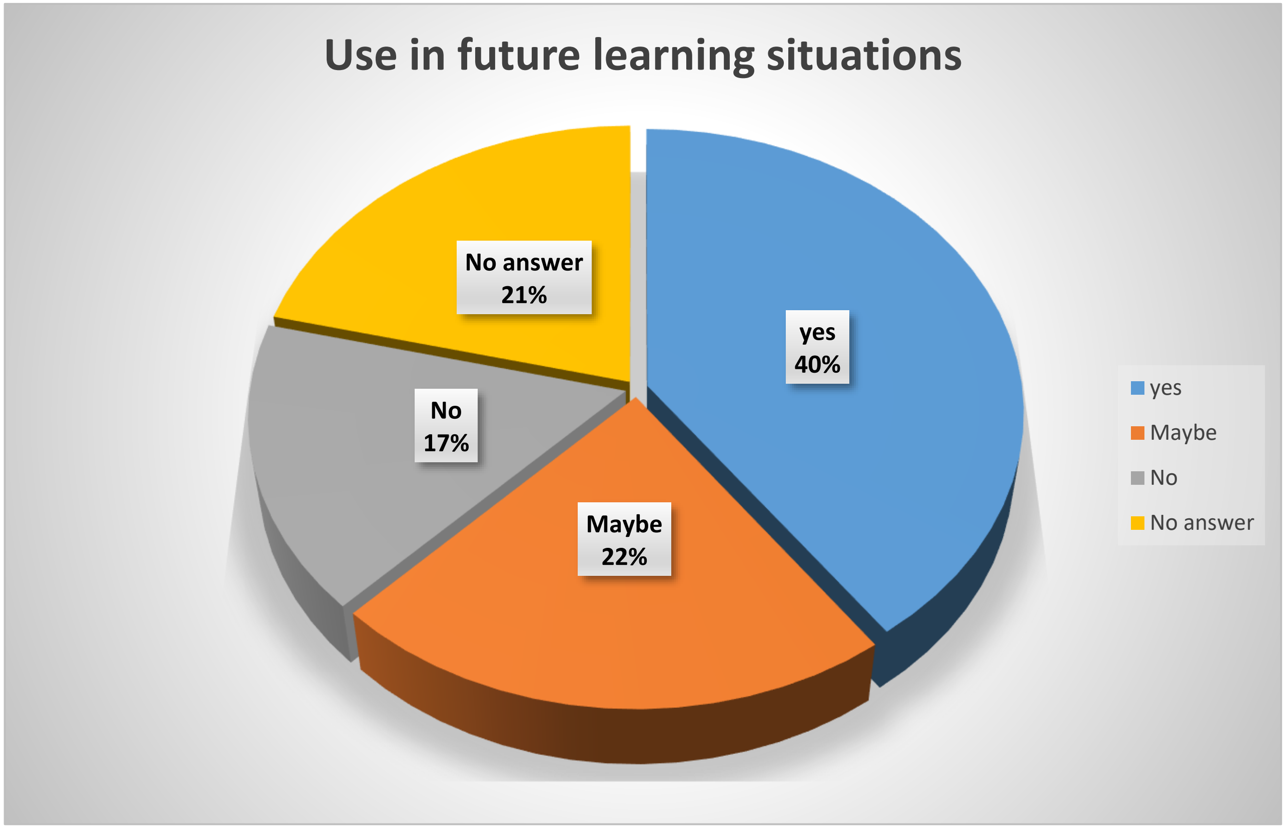
- Acceptance
  (interviews, observation, discussion, questionnaires)
  - **Useful** tool in different subjects for
    - Representing and structuring information and knowledge
    - Preparation of presentations (cheat scheets)
  - Can foster **creativity**
  - Helps to **extract** important information
  - Fun
  - **Generalization** is difficult (for teachers and students)
  - Why not mindmaps? [13]

Acceptance



Satisfaction Flow charts & ER–diagrams in English as foreign language (1 very high – 3 low) $N_{Flow} = 71$, $N_{ER} = 70$ [15]

Practicability & Usability

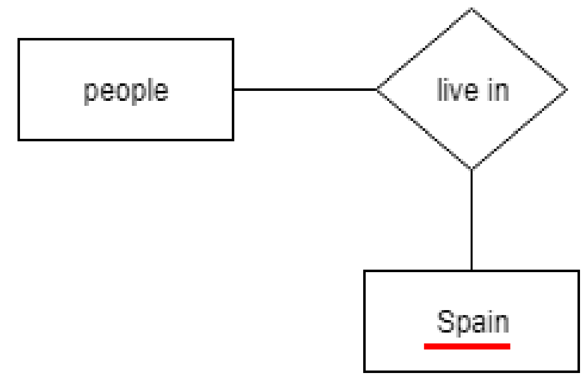


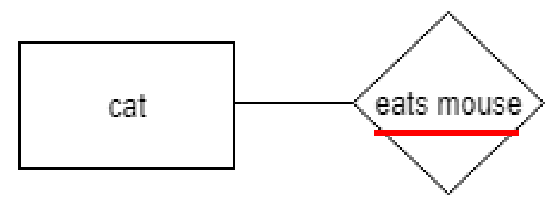
N = 85 (grades 5-8) Modeling in English as foreign language [15]

Results: Comprehension

- Teacher & student opinion
  - Easy to understand
  - Difficult to apply
  - Uncertainty concerning CS criteria
- Problems and Challenges
  - Abstraction difficult[1]
  - Relation and entity in one shape[2]
  - Incorrect or missing attributes

Typical error [1]





Typical error [2]

Modeling Priorities & Criteria

Teaching CT or CS

- Adequate use of
  - diagrams
  - shapes
  - relations
- Abstractions
- Branches
- Attributes
- Logical

Learning strategy

- Subject-specific contents correct
- Essential information available
- Useful
- Adequate use of
  - diagrams
  - relations

Conclusion & Outlook

- Modeling & Computational Thinking (CT)
  - Useful in all subjects, especially languages
  - Basics easy to learn and apply
  - Teaching in 2 steps:
    1. correct shapes
    2. abstraction, generalization
  - Clear priorities: CT or learning strategy
  - Sample materials needed
- Modeling across the subjects
  - Erasmus+ Key Action 2 Strategic Partnership
  - Further studies in different subjects needed:
    - text comprehension & extraction of core information
    - generalization and abstraction
    - effect of different concepts for different purposes

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JKU COOL Lab

- **Informatics Lab** (all visitors > 4 years)
  - Increasing interest and comprehension in **computer science**
  - Projects: CSI Informatics, game design, etc.
  - Weekly (Friday 14:00) and summer lab (July 9-20)
- **Teaching-Learning-Lab** (students, teachers & docents)
  - Interweaving **teacher pre-** and **in-service training** with practice
  - **Computational thinking & digital literacy**
  - Innovative and effective **teaching and learning methods** for
  - Primary, secondary and higher education
- **COOL Talents Club** (grades 5-9)
  - Promoting young **talents in STEM**
  - **Interdisciplinary** projects

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Thank you!

Questions?

Discussion!

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