Informatics Education in Germany

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Outline

1 Informatics in Germany - Frameworks

2 Grades 5-10

- Curricula
  - Bavarian Gymnasium
  - Additional lessons at a comprehensive school in NRW
- Educational standards (GI)

3 Grades 11-13

- National standards
- Content related requirements in NRW
- Central final examinations in NRW

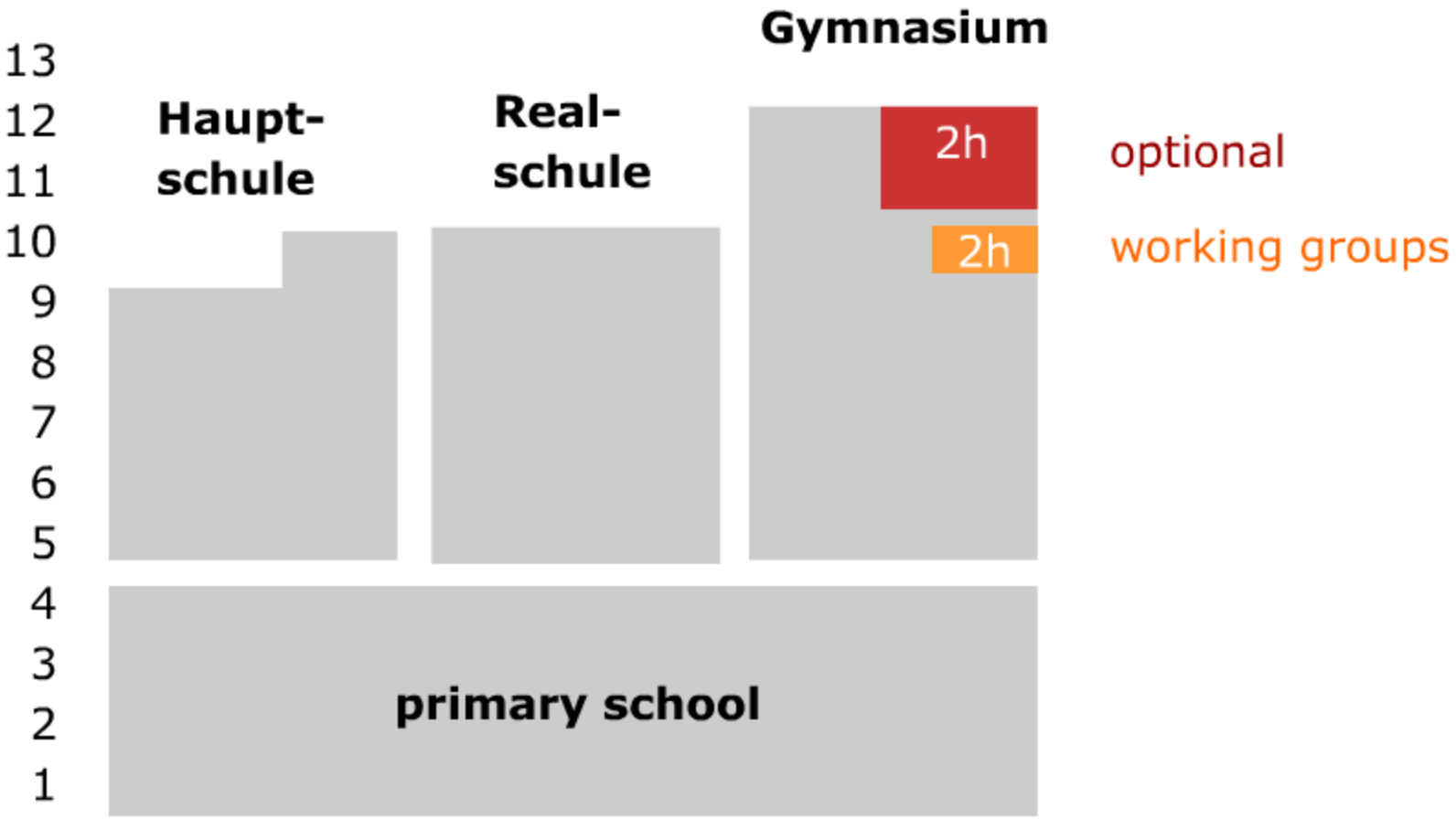
4 Discussion

Germany: 16 countries and 16 educational systems

(Mostly) Common features

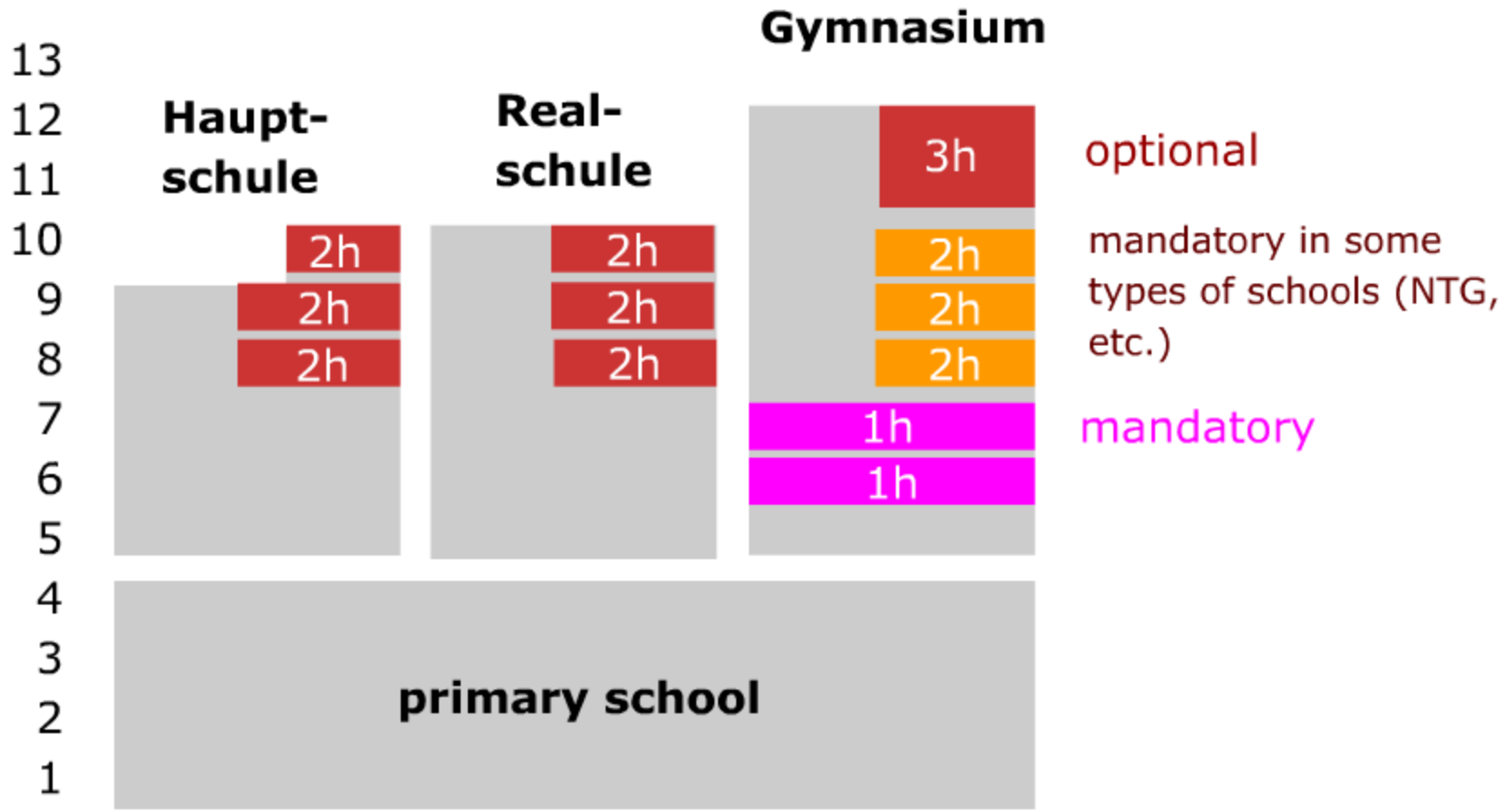
- No informatics in primary schools
- Integrated IT teaching
- Optional informatics classes in all secondary schools
- High school graduation in informatics in all schools

Baden-Württemberg



Moritz Weeger: Synopse zum Informatikunterricht in Deutschland, TU Dresden 2007, http://dil.inf.tu-dresden.de/schule/Weeger/output.inf.tu-dresden.de/homepages/uploads/media/synopse_weeger.pdf

Bavaria


13
12
11
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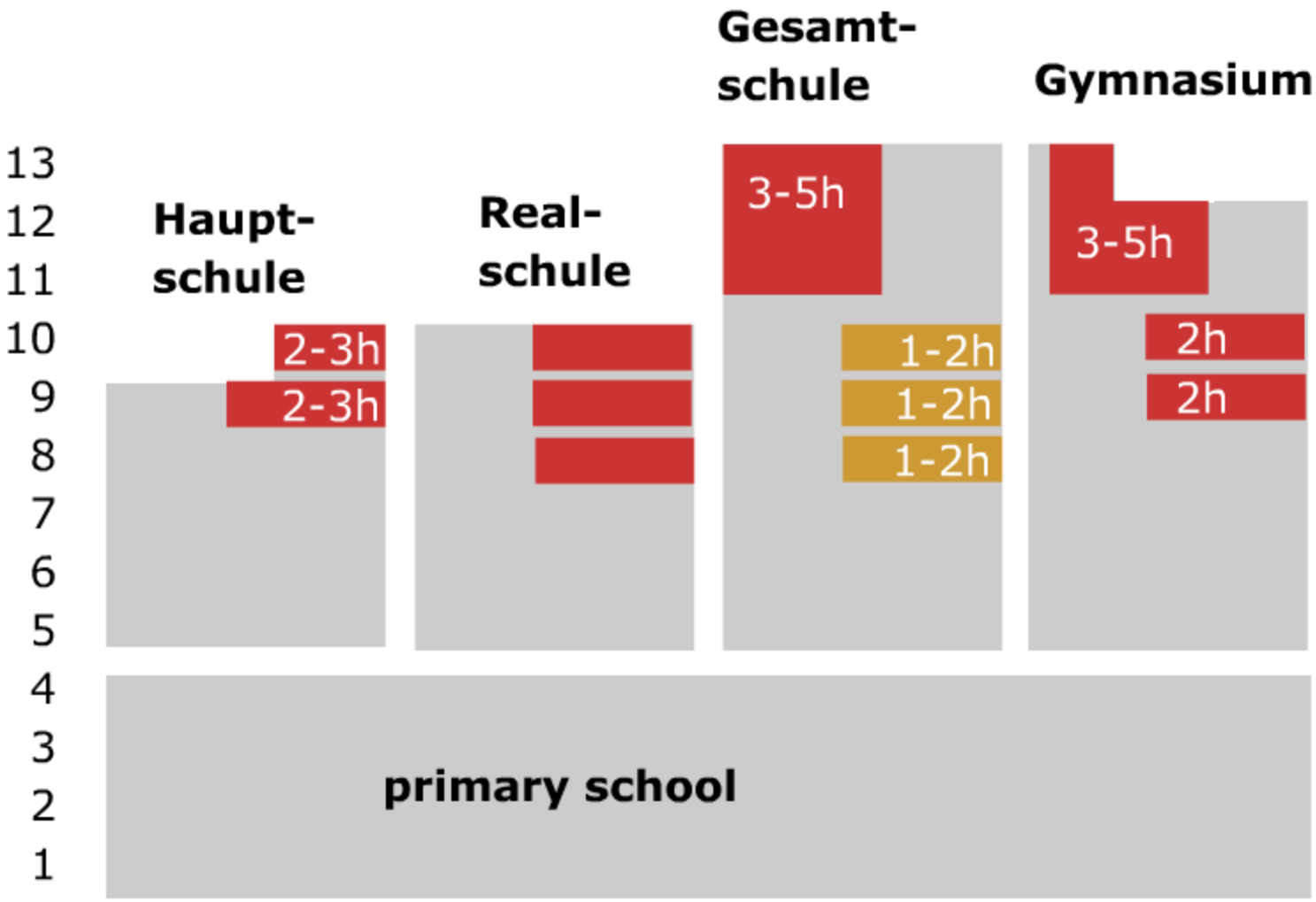
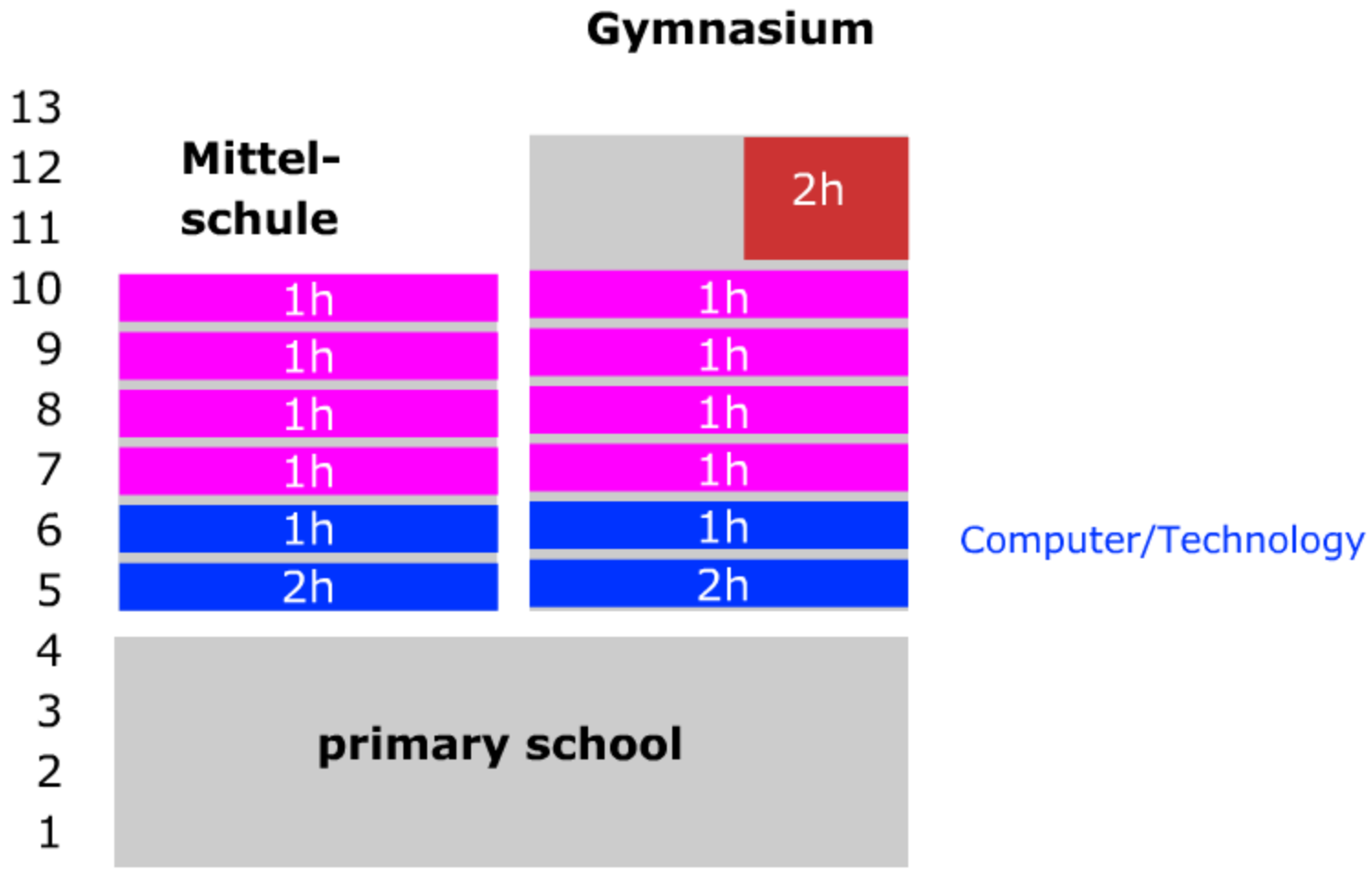
6
5
4
3
2
1
Haupt-schule
Real-schule
Gymnasium
2h
2h
2h
2h
2h
2h
3h
2h
2h
2h
1h
1h
primary school
optional
mandatory in some types of schools (NTG, etc.)
mandatory

North Rhine Westphalia



Saxonia


Gymnasium
13
12
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1
Mittel-
schule
2h
1h
1h
1h
1h
1h
2h
1h
1h
1h
1h
1h
2h
primary school
Computer/Technology

Excursus 1
Integrated IT versus Informatics

Integrated IT education

- Apply IT
- Focus on non-informatics objectives

Informatics (Computer Science)

- Apply and understand IT
- Focus on informatics *concepts* applicable to different domains

Example 1: Word Processing in language lessons

Project: Newspaper

- Visit an editorial office of a local newspaper
- Write an article
- apply a word processor for writing

Primary objectives:
Grammar
Spelling
Communication
Mass media
…

Word processing in informatics

Bebras

Contest on computer fluency

Class: Paragraph

Attributes and values:
Alignment= left

Operations:
Change alignment …

Class: Character

Attributes and values:
font = Times
color = black
size = 44 pt
…

Operations:
Insert
delete
…

Primary objectives:
Object Oriented Thinking
…

Example 2: 3D-Modeling in Math

Sketch-Up Measurement Project:

1) Design: Pretend you have a plot of land that is 10 m by 10 m and wish to make a mini park.

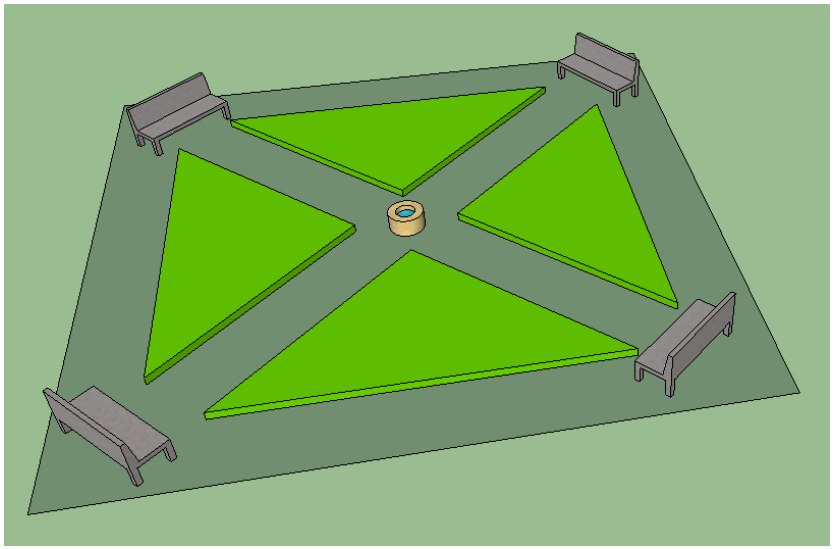
a. Use the entire plot area to design your park.

b. Construct 1.2 m wide walk paths around the perimeter.

c. Ensure that visitors to the park have access 1.2 m wide walk providing access to water fountain in the center by constructing two 1.2 m wide walk path with seating areas at the end of the paths

…

(converted to metric system by M.W.)

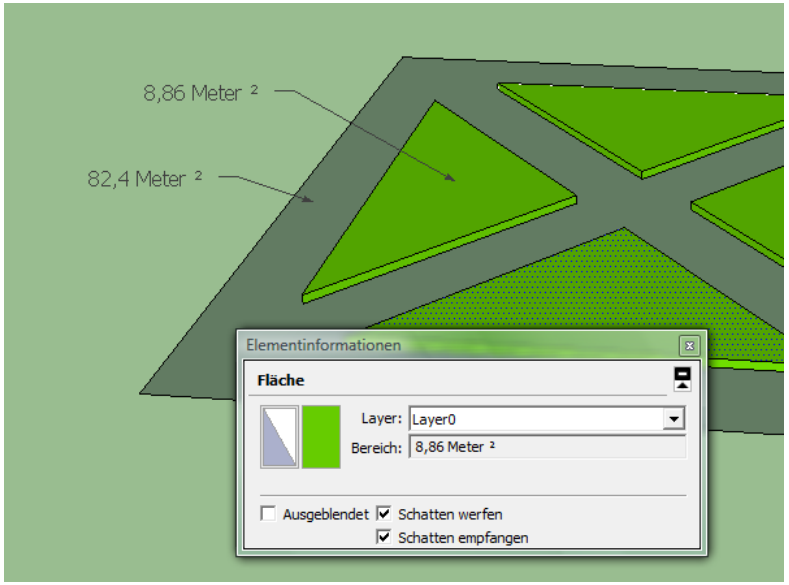


Beth Dichter, Carolyn Gardner, Rachel Stavely-Hale, Antigoni Tzoumakas: How Do We Get From Here to There? Wy Measurement Matter.
http://www.gpsk12.org/professionaldevelopment/masscue/DichterMassCUE.pdf

Example 2: 3D-Modeling in Math

2) Calculate: Use area formulas and show your process for calculating the following:

a. The total area of the park.
b. The total area of the grass and/or flower beds.
c. The total area of the walk paths (include the water fountain and seating areas).
d. Using the “Entity Info” window in SketchUp, how do your calculations compare to the SketchUp values?



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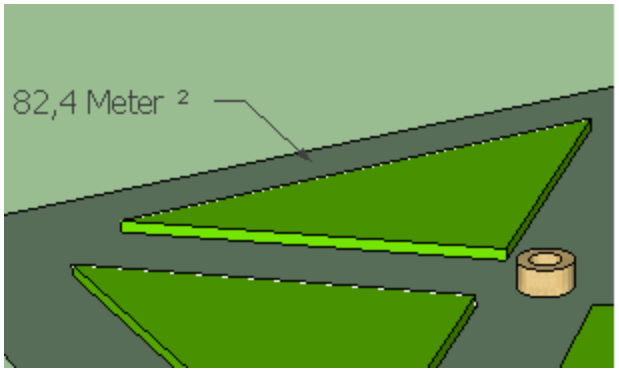
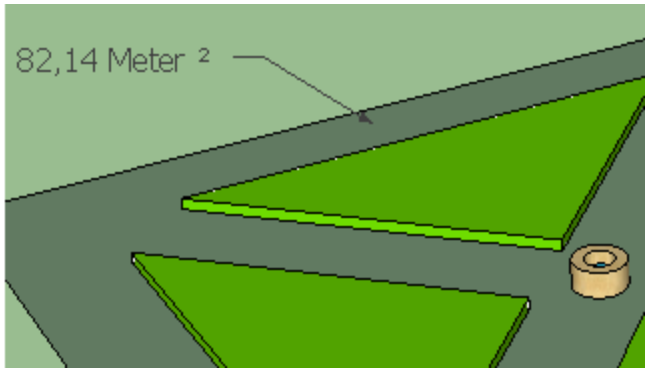
http://www.gpsk12.org/professionaldevelopment/masscue/DichterMassCUE.pdf

Example 2: 3D-Modeling in Math Objectives

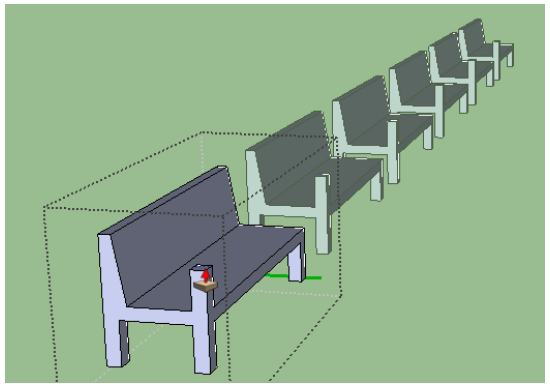
Educational Standards (US)
Calculate perimeter, circumference, and area of common geometric figures such as parallelograms, trapezoids, circles, and triangles.
…



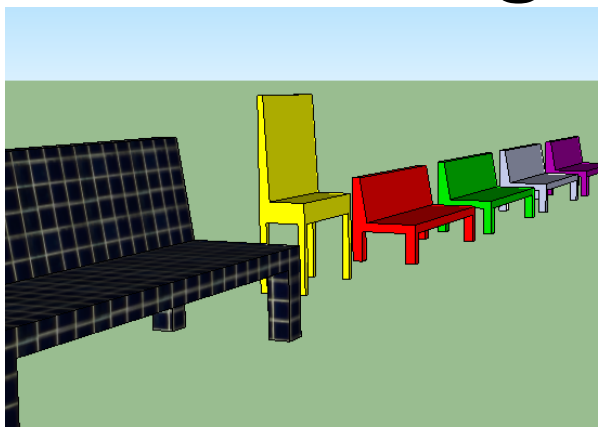


Observation
You need a lot of IT knowledge to solve the problem.
Sometimes th required knowledge is hidden.
(See DGS discussion in the 1990s)

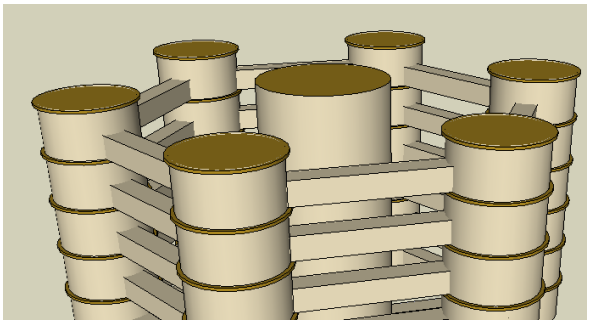
3D-Modeling in Informatics Again: Object oriented thinking



Component and instance



Instances of the same component with different attribute values (scale and material)



Coping with complexity by structuring (building aggregates)

Michael Weigend: *Applying Informatics Knowledge to Create 3D Worlds*. IFIP WCCE 2009, Proceedings, pp. 178-186.
Michael Weigend: 3D-*Modellierung mit SketchUp*. In: Marco Thomas & Michael Weigend (Eds.): Informatik und Kultur - 4. Münsteraner Workshop zur Schulinformatik,. Münster (ZfL-Verlag) 2010.

Contents and Curricula grades 5- 10

Curriculum Bavarian Gymnasium

6

1. Information and data(2 h)
2. information representation and graphics editors(8 h)
3. information representation and word processing (8 h)
4. information representation and multimedia presentation software (5h)
5. Hierarchies and Files (5 h)

7

6. Networkstructures – Internet (12 h)
7. Information exchange – E-Mail (4 h)
8. Describing activity - Algorithms (12 h)

Concepts and usage

Curriculum Bavarian Gymnasium (NTG)

9

1. Functions and data flows;
   spread sheet calculation (18 h)
2. Data modeling and data bases (38 h)

10

3. Objects and processes (36 h)
4. Generalizing and specializing (10 h)
5. Quite complex Example (10 h)

Concepts and usage

Additional lessons at a Comprehensive School in NRW

8	Word processing Spread sheet calculation WWW HTML
9	3D-Modeling (SketchUp) Creating animations (Flash) Designing Presentations
10	Computer Hardware SketchUp Data base systems Descriptive Statistics (Grafstat) Python programming (lists)

2 h a week,
completely optional
no assessment,
independent semester modules

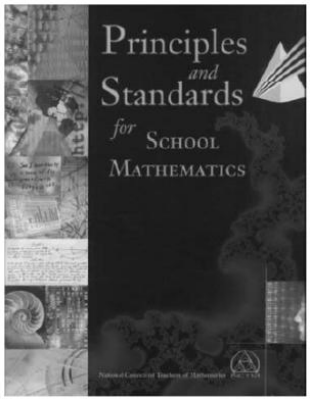
Educational Standards for Informatics Education

Published 2008 by Gesellschaft für Informatik e.V.

Two working groups:

1 Informatics education at school
2 Didactics of informatics

Touch point:
NCTM standards for math education (USA 2000)



Educational Standards

Process

1 Modeling and Implementing
2 Reasoning and judging
3 Structuring and networking
4 Communicating and cooperating
5 Presenting and Interpreting

Content

1 Information and Data
2 Algorithms
3 Formal Languages and Automata
4 Informatics Systems
5 Informatics , Human Life and Society

Minimal standards for two age groups:
grades 5-7 and grades 8-10

C1 Information and Data

Information

Data

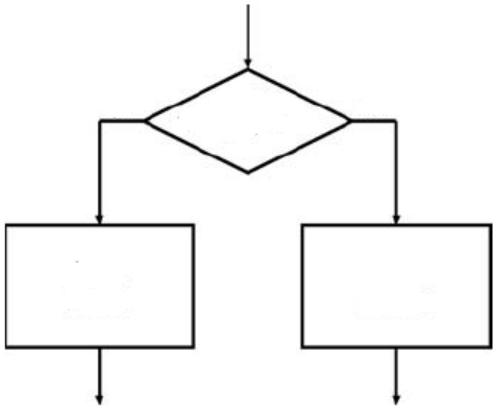
meaningful and relevant for humans

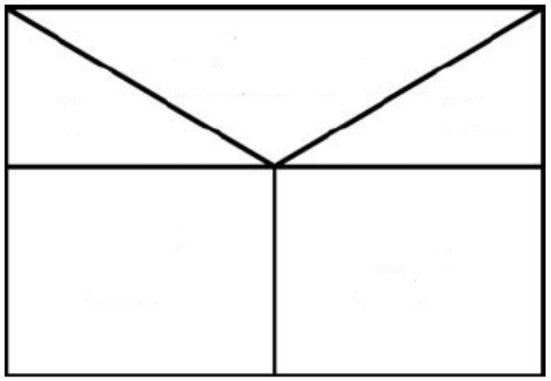
stored, transported and processed by machines

Structure (text documents, vector graphics, …)
Operations (logical, arithmetic, data access)
Data types
Object oriented thinking

C2 Algorithms

Describing activity using natural language (5-7)
Programming (8-10)
Visual representations



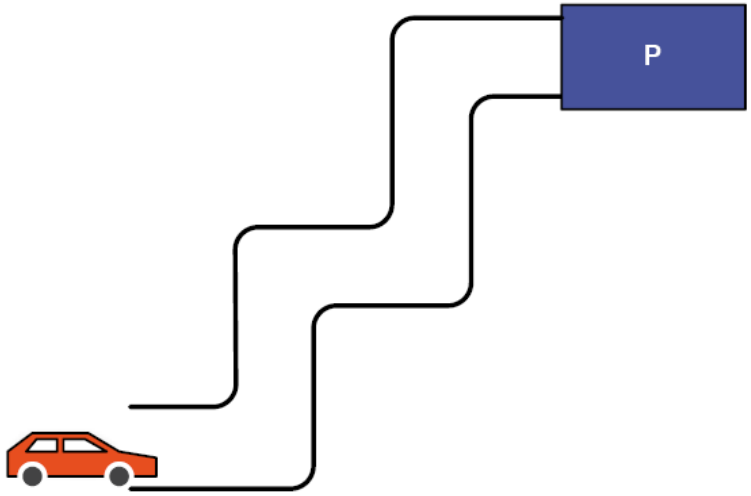


```
if … then … else
```

Bebras Task: Parking

Which sequence of commands describes the way to the parking place?

A) forward, left, forward, left, forward, left, forward, right, forward
B) forward, left, forward, right, forward, left, forward, left, forward
C) forward, left, forward, right, forward, left, forward, right, forward
D) left, forward, right, forward, left, forward, right, forward



This is informatics: programs (and programming languages) for controlling devices

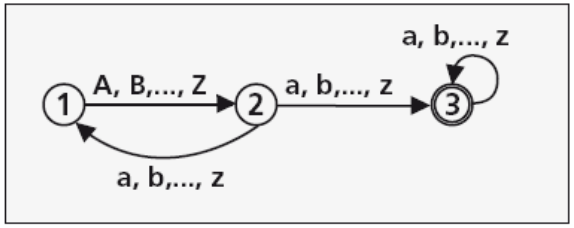
C3 Automata and Languages

Finite state automata
State transition diagrams
Formal languages
Grammars

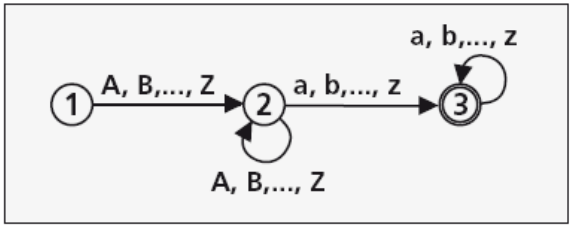
Bebras Task: User Names

Valid user names consist of capitalized names, e.g. CarolineSchilling, Jan PhilippRoth, JackMcGyver.
Which diagram describes the pattern?

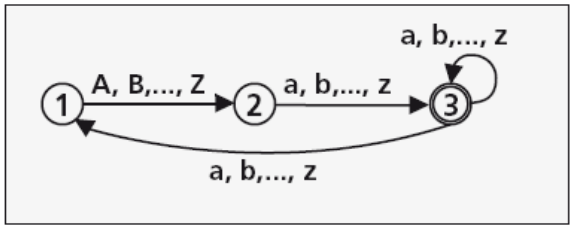
A)



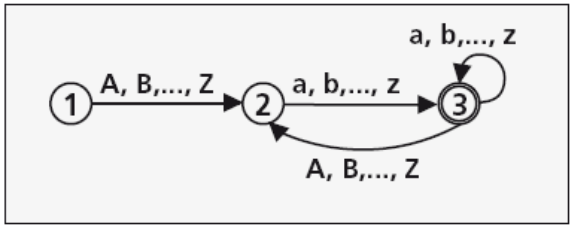
B)



C)



D)



This is informatics: State transition diagrams are used for defining formal languages

C4 Informatics Systems

Hardware components
Software components
Operating system
Networks

C5 Informatics, Human Life and Society

Ethical usage of ICT
Impact of ICT on social life
Risks
Efficient usage of ICT

Bebras Task: Homework

You want to send an e-mail to your teacher asking which is the homework for the next lesson .

What is the most appropriate subject?

A Message from Anke

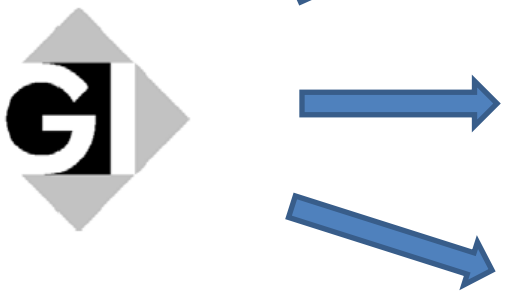
B Urgent

C Homework

D I just wanted to ask what kind of homework I have got to do

This is informatics: You need protocols for efficient communication.

Impact on Curriculum Development



Teacher training
(Universtities)

staff development
(Regional governments)

Teachers
(schools)

Upper Secondary Education grades 11- 13

Kultusministerkonferenz (KMK)

Conference of the Ministers of Education and Cultural Affairs

Objectives

- Comparability of educational certificates and degrees
- National educational standards
- Cooperation education, science, culture

Implementation

- Recommendations
- Contracts (like uniform standards for high school graduation, EPA)

National Standards for High School Graduation

Einheitliche Prüfungsanforderungen

- Core Competencies
- Criteria for task design (especially level of difficulty)
- Example tasks (for regional task designers)

Achievement Levels

Level I: Reproduction of learned facts

write definition, explain an UML class diagrams for an already known scenario, describe and apply a trained algorithms (e.g. sorting)

Level II: Self-contained application of methods

develop a finite state automaton, analyze a new algorithm, develop a data structure

Level III: Create something new

develop a (simple) language for robot control, analyze an interface and write a comment, criticize a model (regarding limits, possibilities …)

All levels have to be regarded, focus on level 2

Content oriented requirements for high graduation (Abitur) in NRW

I Object oriented modeling and implementation

I.1 concepts of OOM

- class, object, attribute, method
- relations between classes (has, is)
- abstract classes,
- class diagram

I.2 data structures

- list, queue, stack, applications: sorting, searching
- Trees, applications
- Sorted tree-

I.3 Modelling and implementing

- Network applications
- Network protocols
- Client applications
- Cryptography

Content oriented requirements for high graduation (Abitur) in NRW

II. Relational Data Base Systems

- Entity relationship model
- Normal forms (1 – 3)
- Relations
- Using a real DBS
- SQL
- Privacy and personal rights

III Finite State Automata and Formal Language

State Oriented Modeling

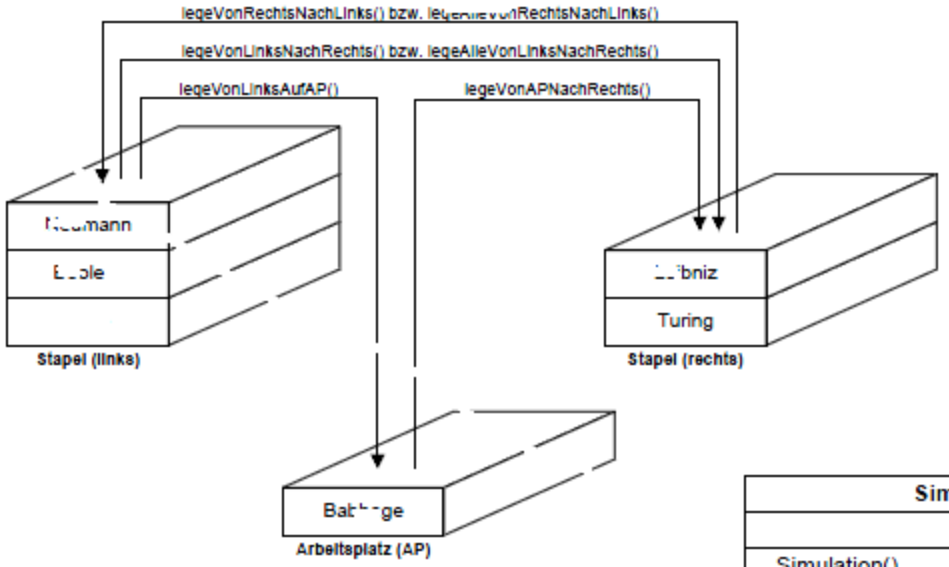
Representation od FSA using state transitian diagrams and tables

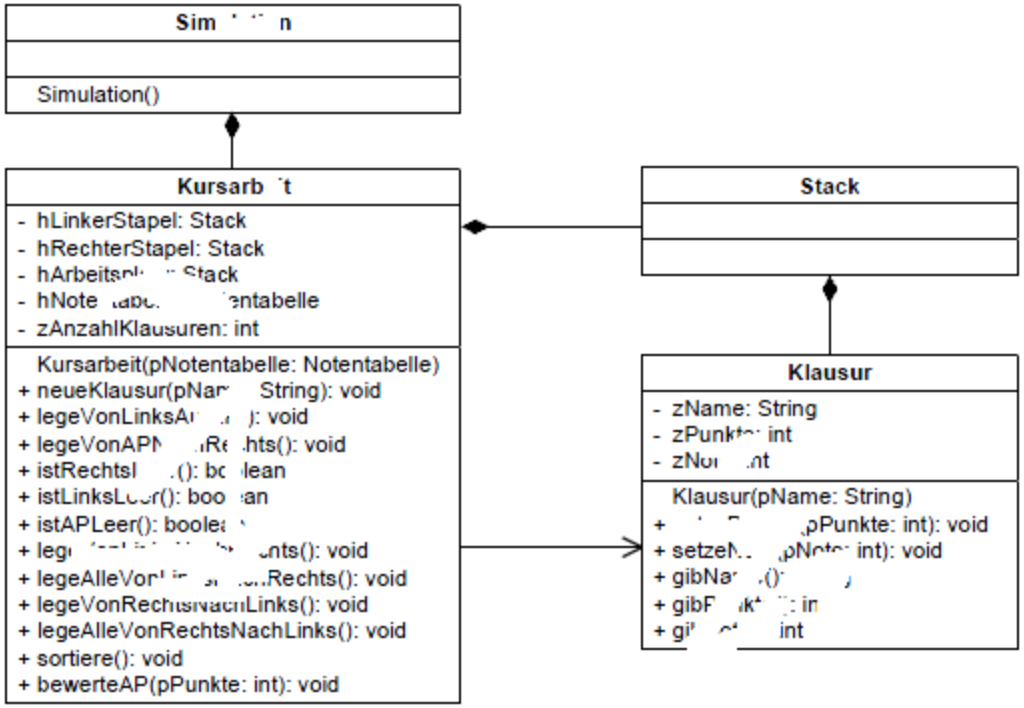
Acceptor

Regular Language

Parsing (only advanced level classes

Example: Modeling and Implementing





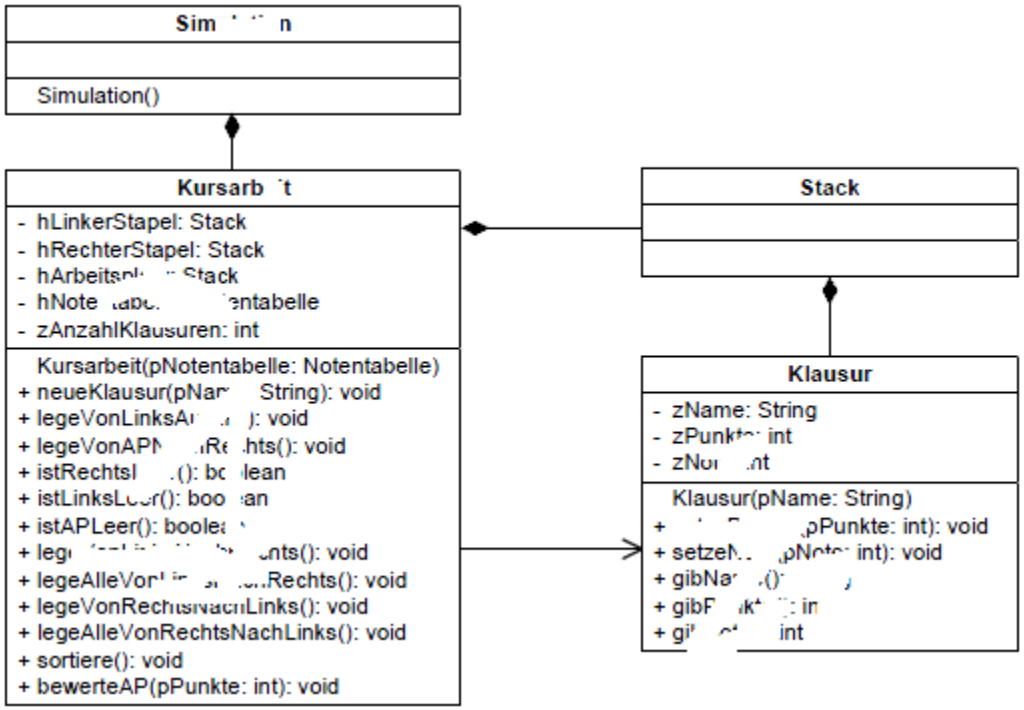
a) Implement the class Klausur using Java. You need not to implement all methods, just …

(level II)

Example: Modeling and Implementing

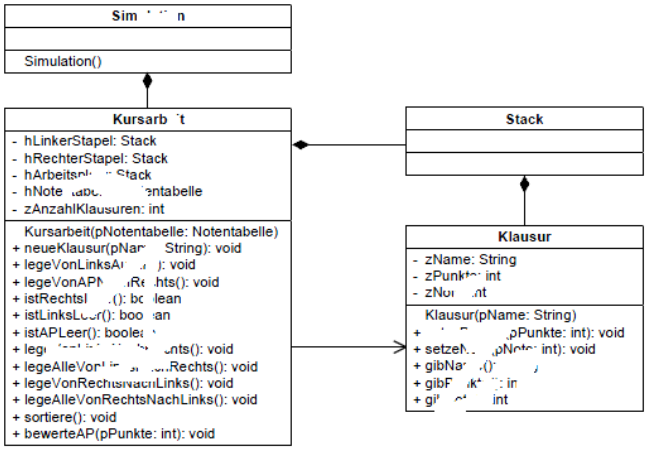
b) Implement an additional feature and extend the class structure.
(level III)

Write a comment.
(level I)



Example: Modeling and Implementing

c) Implement some methods of a class on the basis of the UML diagram and an exact specification (precondition, postcondition)



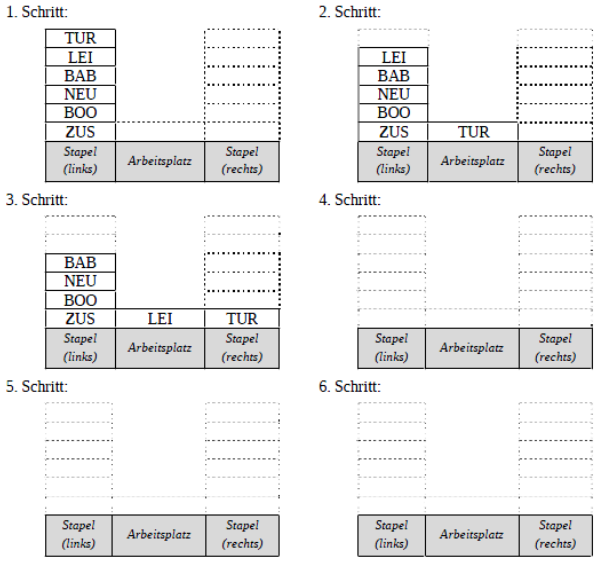
Die Klasse Kursarbeit

Konstruktor *nachher*	**`Kursarbeit()`** Eine leere Kursarbeit ist erzeugt.
Anfrage *nachher*	**`istLinksLeer(): boolean`** Die Anfrage liefert den Wert **`true`**, wenn der linke Stapel keine Klausuren enthält, sonst liefert sie den Wert **`false`**.
Anfrage *nachher*	**`istRechtsLeer(): boolean`** Die Anfrage liefert den Wert **`true`**, wenn der rechte Stapel keine Klausuren enthält, sonst liefert sie den Wert **`false`**.
Anfrage *nachher*	**`istAPLeer(): boolean`** Die Anfrage liefert den Wert **`true`**, wenn sich keine Klausur auf dem Arbeitsplatz befindet, sonst liefert sie den Wert **`false`**.
Auftrag *nachher*	**`legeAlleVonLinksNachRechts()`** Der rechte Stapel enthält alle Klausuren, die vorher auf dem linken Stapel lagen, in umgekehrter Reihenfolge. Der linke Stapel enthält keine Klausuren mehr. Befand sich keine Klausur auf dem linken Stapel, so wurde nichts verändert.
Auftrag *nachher*	**`legeAlleVonRechtsNachLinks()`** Der linke Stapel enthält alle Klausuren, die vorher auf dem rechten Stapel lagen, in umgekehrter Reihenfolge. Der rechte Stapel enthält keine Klausuren mehr. Befand sich keine Klausur auf dem rechten Stapel, so wurde nichts verändert.
Auftrag *nachher*	**`legeVonAPNachRechts()`** Befand sich eine Klausur auf dem Arbeitsplatz, so ist diese jetzt die oberste Klausur auf dem rechten Stapel. Andersfalls wurde nichts verändert.
Auftrag *nachher*	**`legeVonLinksAufAP()`** Befand sich keine Klausur auf dem Arbeitsplatz und befand sich auf dem linken Stapel noch mindestens eine Klausur, so liegt die oberste Klausur des linken Stapels jetzt auf dem Arbeitsplatz. Andernfalls wurde nichts verändert.

Example: Modeling and Implementing

d) Document the execution of the algorithm (first steps)

```
01  public void sortiere() {
02    legeVonAPNachRechts();
03    for (int i=0; i < zAnzahlKlausuren; i++) {
04      legeAlleVonRechtsNachLinks();
05      zeigeSchritt();
06      legeVonLinksAufAP();
07      zeigeSchritt();
08      while (!hLinkerStapel.isEmpty()) {
09        Klausur lKlausur1 = (Klausur)hArbeitsplatz.top();
10        Klausur lKlausur2 = (Klausur)hLinkerStapel.top();
11        String lName1 = lKlausur1.gibName();
12        String lName2 = lKlausur2.gibName();
13        if (lName1.compareTo(lName2)<0) {
14          legeVonLinksNachRechts();
15        } else {
16          legeVonAPNachRechts();
17          legeVonLinksAufAP();
18        }
19        zeigeSchritt();
20      }
21      legeVonAPNachRechts();
22      zeigeSchritt();
23    }
24  }
```



Altogether 12 pages of material for the students

Informatics education in Germany Summary

Diversity of organizational frameworks, didactical approaches

In grades 5-10 mostly optional informatics classes but integrated IT teaching in all types of schools

Much freedom of lesson design in grades 5-10

Standardization of content in grades 11-13 through central final examinations

Thank you for your attention!