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10+10=100? – BASIC DIGITAL EDUCATION IN PRIMARY SCHOOLS

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Abstract

In 2012 experts met in Graz/Austria to formulate Information Technology (IT) and media competences for students at primary schools. The results addressing digital competences were finally made public on a platform named digi.komp4. The two categories in these competences by name *informatics systems* (Computer's Inside) and *concepts* (informations' representation) match with the topic of the course perfectly. The paper describes the single steps of the teaching process in form and content. The teaching methods and the share the students had in the single steps of the course are illustrated integratively.

Keywords: Basic Digital Education, media competences, informatics system, teaching methods, students' activity.

1. Population and Motivation

Approximately twenty years ago in 1998 ten years old students from the Abfalter Primary School in Salzburg visited the department of computerscience education of the Paris-Lodron University of Salzburg.

Figure 1. Population

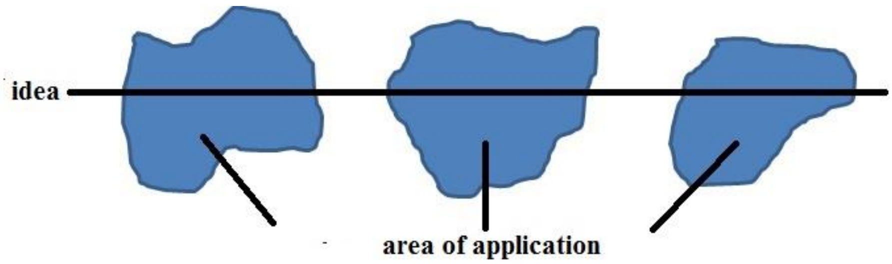
Attending a special course treating an age-appropriate introduction to *Computers' inside* was the motivation for the visit. The course was designed by a special form of *Problem Based Learning* (Weber, 2007), the Cognitive Apprenticeship Method. Stepwise transitions characterize this method. The steps extend from **Modelling** and **Coaching** to **Articulation**, **Reflection** and **Exploration** via **Scaffolding** as intermediate step. The teacher (called Expert or Master) moves back from the teaching process gradually whereas the students (called Novice) play an increasing part in the process.

2. Computer's Inside: How do Computers communicate?

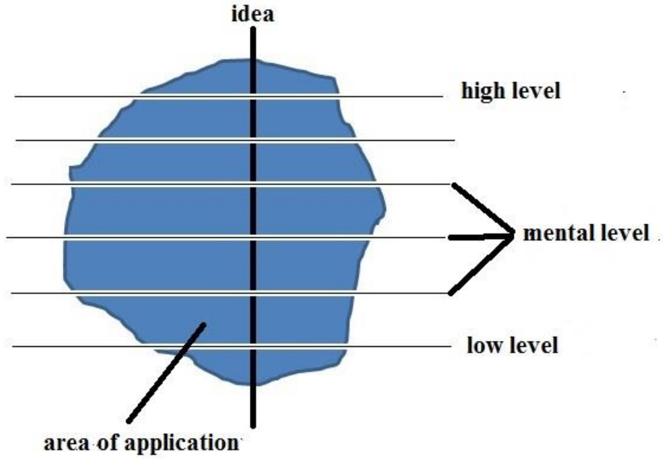
The answers to this specific initial question are given in the following four categories of Information Technology and Media Competences.
These categories will be phrased as activities or strategies following the concept of Fundamental Ideas in Mathematics which are characterized …

> … as bundle of strategies or activities, strategies or techniques, which …
> (1) … can be identified in the development of mathematics from a historical point of view.
> (2) … appears sustainable to order courses of instruction vertically.
> (3) … turns up appropriate to speak about mathematics.
> (4) … makes courses in mathematics flexible and transparent.
> (5) … owns a corresponding linguistic and enactive archetype in languages and everyday thinking. (Schweiger, 2010, p. 12, 13)

Additionally the following categories show the different dimensions of Fundamental Ideas expressed by Andreas Schwill (1993):
The **Horizontal Dimension** is described by Schwill as thinking principle with "… *an widespread applicabilty in multiple areas, an they integrate and put the multitude of phenomena in order …*".



The **Vertical Dimension** is described by Schwill as thinking principle that "… *structures the contents within an application vertically* …" which means "… *fundamental ideas can be communicated at nearly any arbitrary level (from primary level students to University level students) successfully …*".



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Following Schwill's list of fundamental ideas as thinking principles they needn't only have **wideness** expressed as **Horizontal Dimension** and **richness** expressed as **Vertical Dimension** but "… *must have … an anchorage in day-by-day thinking,* ... and own "… *realms of life relevance* …". This attribute is labeled by **Criterion of Sense**.
Finally the thinking principles must own a historical dimension. Schwill expresses this characteristic as **Criterion of Time**.

- Category 1: Using Information Technology
- Category 2: Exchanging data using the Man-Machine Interface
- Category 3: Communicating
- Category 4: Representing and structuring data

2.1 Category 3 & 4: Teaching Process

According the Cognitive Apprenticeship method the first step of the teaching process was frontal in an ex-cathedra head-on presentation (Meyer 1987). The discussion of the topics Communicating, Representing and structuring data was motivated by tying in with the students` preknowledges of Natural numbers ℕ. The students were surprisingly busy with only two digits (0 and 1) instead of ten digits (0, 1, .. 9) of ℕ which they were familiar with in the steps of **Modelling** and **Coaching**.

For the purpose namely to transform numbers of the common form into the new binary form they had to cope with *division with remainder* as an operating strategy. The following statements out of the model M4 (intersection of primary level (4^{th} level) and secondary level) for Primary Schools in mathematics in Austria legitimate the handling of this operation with primary school students:

> **Competences concerning *Modelling***
> The students can undertake arithmetical operations and techniques.
>
> **Competences concerning *Communicating***
> The students are able to keep hold of their approaches in appropriate forms of representation.
>
> **Competences concerning contents (*Operating*)**
> The students have insights into the nature of arithmetic operations at one's disposal.
> (https://www.bifie.at/wp-content/uploads/2017/06/Deskriptoren_BiSt_M4.pdf-call 31st of October 2020)

Concerning the content Figure 2 will document the structured representation at the blackboard given by the teacher.

93	:	2 =	46 R: 1
46	:	2 =	23 R: 0
23	:	2 =	11 R: 1
11	:	2 =	5 R: 1
5	:	2 =	2 R: 1
2	:	2 =	1 R: 0
1	:	2 =	0 R: 1

Figure 2. Structured representation of a division with remainder applied to 93

Analysing the division of 93 stepwise finally leads to the binary number 1011101. To gain the correct result the students must be aware of the bottom up strategy in their analysis.

The addition of binary numbers was picked out in analogy to the addition of natural numbers in this presentation by the teacher. The students had to pay attention to the fact that they can only resort to two digits when adding binary numbers: $0 + 0 = 0$, $0 + 1 = 1$ and $1 + 0 = 1$ (each with no carry forward) but $1 + 1 = 0$ (with 1 carry forward).

The students transformed natural numbers given by the teacher into binary coded numbers and generated sums of these numbers manually in the subsequent **Scaffolding step**.

2.2 Category 1 and 2: Teaching process

Approximately 45 minutes later the students moved on to the computer room. There they unionised in groups for the exercise collaborating phase (Naase 2013). The request of the following steps of **Articulation**, **Reflection** and **Exploration** in this phase was practice on behalf of recapitulation, application and memorizing. (Ambrus, 2003)

For these steps Javascript applications were prepared. One application named *binary_ calculator* carries out the transformation from decimal to binary numbers, the second one *binary_calculator_sum* was programmed to add binary numbers. The categories Man-Machine Interface and Communicating of the competence model come to the fore. The applications were used to fulfill and to validate the results of the operations discussed in the teaching process before with the help of computers.

In these final steps the students were talking among each other about the techniques for solving the problems a lot. Clearly the acoustic level increased as expected. This signal for a higher communication competence was very welcomed as communication is a category in numerous competence models of IT (Fuchs & Landerer, 2005) and it is expressed in M4 as mentioned before.

Subsequently the contents in this phase of the teaching process will be illustrated by the prototypical use of the applications.

Prototypical use-Application *binary_calculator*

Starting the application the computer displays a window where the students can enter the decimal number which should be transformed into binary representation.

Figure 3. Input Windows (decimal number) application *binary_calculator*

The decimal number 233 is entered exemplarily.

Figure 4. Decimal number 233 entered in *binary_calculator*

The application answers with binary number 11101001.

Prototypical use-Application *binary_calculator_sum*

When starting the second application the screen looks as follows.

Figure 5. First decimal summand 102 entered in *binary_calculator_sum*

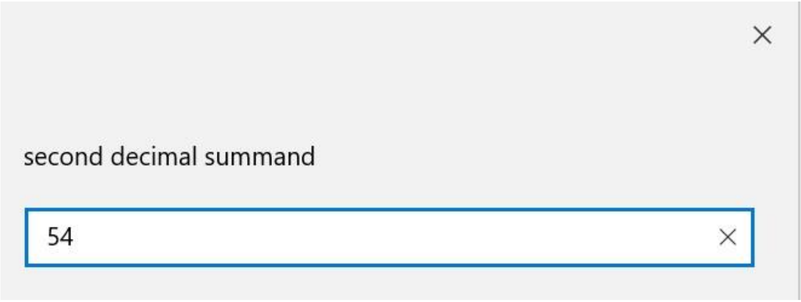

Figure 6. Second decimal summand 54 entered in *binary_calculator_sum*

The application answers with the whole addition in binary representation including the summands and the sum:

$$1100110+110110=10011100.$$

3. Observations and Perspektive

- The long-standing interest and motivation of the students argued for the attractiveness of the chosen topic.

- The Cognitive Apprendice Method with its steps appeared as approriate approach for achieving the intended goals.

- A meaningful perspective for pressing ahead this theme might be to discuss the binary coding of characters (ASCII Code)

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