**Task 2 (see Triantafillou & Potari, 2010)**

Mathematical topic: Numbers: The place value in the ten numeration system

Grades: Upper Primary – Lower secondary – vocational education

Connection of Mathematics with the workplace telecommunication

## Presenting or Describing the Activity

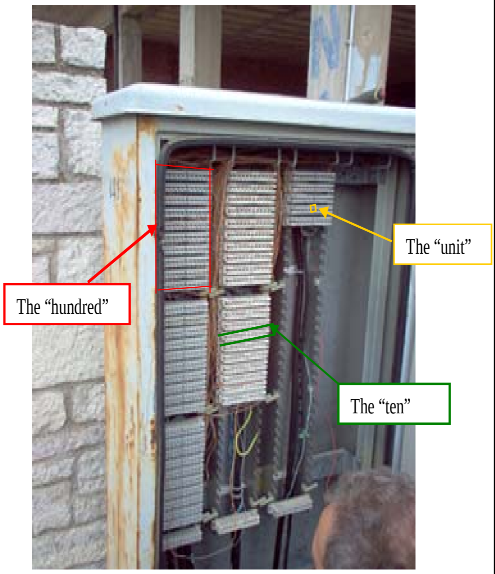


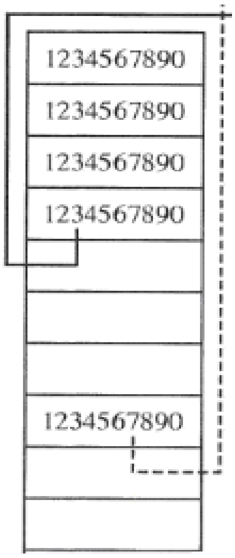

Fig. 1. The telecommunication closet

*The context:* A typical problem that the technicians in a telecommunication organization face is to trace a wire in order to identify a reported fault.

The wires start from the organization building, go through a specific board, the telecommunication closet (Fig.1), and are distributed to the local subscribers. The closet consists of two frames. The one in the middle as shown in Fig. 1 consists of the incoming wires and the ones on the right and the left distribute the outgoing wires to different boxes around the area. These boxes are usually mounted on a pole near the subscriber's house.

*How the place value emerges in this context*

Each frame in the closet consists of patch boards separated in tens and each patch board consists of 10 pairs of wires. A patch board or patch panel is a device with 10 sockets into telecommunication wires can be inserted to different temporary circuits.



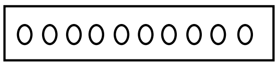



Fig. 2: The schematic representation of one patch-board with 10 sockets.

Fig. 3: The schematic representation of the "hundred" in the closet or 10 patch-boards connected together.

Each pair of wires has a particular place in the patch board (see Fig. 2), so each patch board has 10 places ordered from left to right and from the top to the bottom (see Fig. 3) of the frame (incoming or outgoing).

Moreover, each patch board from the outgoing frame corresponds to a Box of the same order (e.g. the 3rd patch board corresponds to the Box No 3).

The structure of the wires in each frame in the telecommunication closet and in the set of boxes is a concrete representation of the place value system where the place in the patch board represents the 'unit', the patch board represents the 'ten' and the ten-patch boards together represent the 'hundred'.

In this setting the technicians could easily perform on the following tasks: (a) correspond every natural number to the composite unit this number belongs to (for example 165 belongs to the $17^{th}$ ten and to the $2^{nd}$ hundred) and vice versa and (b) identify all the numbers that generate a composite unit (for example the $9^{th}$ ten is generated by the numbers 81, 82 … 90).

*How this aspect of place value differs from the one in school*

In school the place value in base-ten numeration systems has been treated in a rather mechanical way as the students learn for example that the number 39 consists of 9 units and 3 tens. However, little emphasis is placed on the conceptual structures underlying the construction of the place value concept. In this setting the representation of the number 39 requires an understanding that the number is over 30 so the $4^{th}$ ten has started to be completed up to the ninth place. So in this case the representations 39 and 04/9 are equivalent representations of the same number.

Concluding, the concrete model in this case emphasizes the process of generating a composite unit (i.e. the tens) in an ordered way.

**Possible students' activities :**

- Students can be asked to sketch or construct their own Telecommunication closet in their home or school area (e.g. 140 incoming and 230 outgoing wires).
- Each student in a class can be a subscriber so teacher assigns to him/her a particular place in this closet. For example, Anna as a subscriber can have an 'identity' such as 46 (incoming) - 79 (outgoing)). Anna finds her place in the closet and the corresponding Box. Is James (identity 23 - 80) in the same Box with Anna? Or group the students that correspond to the same "hundred" in the incoming or outgoing framework. Who is the first or the last subscriber in this hundred?
- Students locate in their closet the empty places and assign 12 new subscribers. With whom of the new subscribers Anna is in the same Box? Who is before and after Anna in the same Box or in the next Box?
- It is reported that the Box NO 42 has a problem and the teacher as a technician has to locate the specific patch board on the closet. The students without using the

closet have to guide the teacher to find the closet and the particular subscribers that belong in this Box.

***Extension***

Is there a way to find a formula that represents all the numbers that belong in the nth composite unit

(e.g. nth ten is generated by the 10 consecutive numbers 10(n-1)+1, 10(n-1)+2, ... 10(n-1)+9, 10(n-1)+10)= 10n)

Triantafillou and Potari (2010). Mathematical Practices in a Technological Workplace. Educational Studies in Mathematics, 74, 275-294.